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THE

ANATOMY

OF THE

HUMAN BODY.

CONTAINING

THE ANATOMY

OF

THE BONES, MUSCLES, JOINTS, HEART, AND ARTERIES,

By JOHN BELL, SURGEON;

AND THAT OF

THE BRAIN AND NERVES, THE ORGANS OF THE SENSES, AND THE VISCERA,

By CHARLES BELL, SURGEON;

THE THIRD EDITION.

IN THREE VOLUMES.

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THE

ANATOMY

OF THE

HUMAN BODY.

VOL. I.

CONTAINING THE ANATOMY OF

THE BONES, MUSCLES, AND JOINTS;

THE HEART AND CIRCULATION;

AND

THE LUNGS.

2324

TO

ALEXANDER WOOD,

SURGEON,

WHOSE ABILITIES, AND SKILL, AND DISINTERESTED CONDUCT,

HAVE RAISED HIM, BY COMMON CONSENT,

TO THE FIRST RANK, IN A MOST USEFUL PROFESSION;

CONDUCTING HIM, IN HONOUR, TO THAT PERIOD OF LIFE,

IN WHICH, HE MUST FEEL WITH PLEASURE,

HOW COMPLETELY HE ENJOYS THE CONFIDENCE OF THE PUBLIC,

AND THE ESTEEM OF ALL GOOD MEN,

THIS BOOK OF ANATOMY,

IS PRESENTED,

BY HIS PUPIL,

JOHN BELL.

PREFACE.

TO thoſe, who are at all acquainted with books on anatomy, the appearance of a new one on the ſubject will not be ſurpriſing. To thoſe, who are not yet acquainted with ſuch writings, I have only to ſay, that I have written this book, becauſe I believed that ſuch a one was needed, and muſt be uſeful. I have endeavoured to make it ſo plain and ſimple, as to be eaſily underſtood; I have avoided the tedious interlarding of technical terms (which has been too long the pride of anatomiſts, and the diſgrace of their ſcience), ſo that it may read ſmoothly, compared with the ſtudied harſhneſs, and, I may ſay, obſcurity of anatomical deſcription. If an author may ever be allowed to compare his book with others, it muſt be in the mechanical part; and I may venture to ſay, that this book is full and correct in the anatomy, free and general in the explanations, not redundant, I hope, and yet not too brief.

If, in the courſe of this volume, I ſhall appear to have given a place and importance to theories far higher than they really deſerve, my reader will naturally feel how uſeful they are in preſerving the due balance between what is amuſing, and what is uſeful; between the looſer doctrines of functions, and the cloſe demonſtration of parts. He will be ſenſible, how much more eaſily theſe things can be read in the cloſet, than taught in any public courſe; he will, I think, be ready to acknowledge, that I introduce ſuch theories only, as ſhould connect the whole, and may be fairly diſtinguiſhed as the phy-

ſiology

ſiology of acts; and he will perceive, that in this too, I feel a deference for the public opinion, and a reſpect for the eſtabliſhed courſe of education, which it is natural to feel and to comply with.

Thus, perhaps it is leſs immodeſt for an author to put down what he thinks he may honeſtly ſay concerning his own book, than to omit thoſe apologies which cuſtom requires, which give aſſurance, that he has not entered upon his taſk raſhly, nor performed it without ſome labour and thought, and which are the trueſt ſigns of his reſpect for the public, and of his care for that ſcience to which he has devoted his life.

With theſe intentions and hopes, I offer this book to the public; and more particularly to thoſe in whoſe education I have a chief concern; not without a degree of ſatisfaction at having accompliſhed what I think cannot fail to be uſeful, and ſurely not without an apprehenſion of not having done (in this wide and difficult ſubject) all that may be expected or wiſhed for.

Every book of this kind ſhould form a part of ſome greater ſyſtem of education: it ſhould not only be entire in its own plan, but ſhould be as a part of ſome greater whole; without which ſupport and connection, a book of ſcience is inſulated and loſt. This relation and ſubſerviency of his own particular taſk to ſome greater whole, is firſt in an author's mind: he ventures to look forward to its connection with the general ſcience, and common courſe of education; or he turns it to a correſpondence and harmony with his own notions of ſtudy; and if theſe notions are to give the complexion and character to any book, it ſhould be when it is deſigned for thoſe entering upon their ſtudies, as yet uncertain where to begin, or how to proceed.

Hardly any one has been ſo fortunate as to purſue the ſtudy of his own ſcience under any regular and perfect plan; and there are very few with whom a conſciouſneſs of this does not make a deep and ſerious impreſſion at ſome future period, accompanied with ſevere regret for the loſs of time never to be retrieved. In medicine, perhaps, more than in any other ſcience, we begin our ſtudies

ſtudies thoughtleſs and undecided, following whatever is delightful, (as much is delightful) neglecting the more ſevere and uſeful parts: but as we advance towards that period in which we are to enter upon a moſt difficult profeſſion, and to take our place and ſtation in life, and when we think of the heſitation, anxiety, and apprehenſion with which we muſt move through the firſt years of practice, we begin to look back with regret on every moment that is paſt; with a conſciouſneſs of ſome idle hours; and (what is more afflicting ſtill) with an unavailing ſenſe of much ill-directed, unprofitable labour: — for there is no ſtudy which a young man enters upon with a more eager curioſity; but, not inſtructed in what is really uſeful, nor ſeriouſly impreſſed with the importance of his future profeſſion, he thinks of his ſtudies rather as the amuſement, than as the buſineſs, of life; ſlumbers through his more laborious and uſeful taſks, and ſoon falls off to the vain purſuit of theories and doctrines.

If I were not perſuaded of the important conſequences, of the infinite gain or loſs, which muſt follow the firſt ſteps in every profeſſion, I ſhould not feel, but, above all, I ſhould not venture to ſhow, an anxiety, which may be thought affected by thoſe who cannot know how ſincere it muſt be; for, in our profeſſion, this is the courſe of things, that a young man, who, by his limited fortune, or the will of his friends, by abſence from his native country, or by the deſtination of his future life, is reſtricted to a few years of irregular, capricious, ill-directed ſtudy, throws himſelf at once into the practice of a profeſſion, in which, according to his ignorance or ſkill, he muſt do much good or much harm. Here there is no time for his excurſions into that region of airy and fleeting viſions, and for his returning again to ſedate and uſeful labour: there is no time for his diſcovering, by the natural force of his own reaſon, how vain all ſpeculations are; — in but a few years, at moſt, his education is determined; the limited term is completed, ere he have learnt that moſt uſeful of all leſſons—the true plan of ſtudy; his opportunities come to be valued (like

every other happineſs), only when they are loſt and gone.

Of all the leſſons which a young man entering upon our profeſſion needs to learn, this is, perhaps, the firſt, — that he ſhould reſiſt the faſcinations of doctrines and hypotheſes, till he have won the privilege of ſuch ſtudies by honeſt labour, and a faithful purſuit of real and uſeful knowledge. Of this knowledge, anatomy ſurely forms the greateſt ſhare. — Anatomy, even while it is neglected, is univerſally acknowledged to be the very baſis of all medical ſkill. — It is by anatomy that the phyſician gueſſes at the ſeat, or cauſes, or conſequences, of any internal diſeaſe: without anatomy, the ſurgeon could not move one ſtep in his great operations; and thoſe theories could not even be conceived, which ſo often uſurp the place of that very ſcience, from which they ſhould flow as probabilities and conjectures only, drawn from its ſtore of facts.

A conſciouſneſs of the high value of anatomical knowledge never entirely leaves the mind of the ſtudent. He begins with a ſtrong conviction that this is the great ſtudy, and with an ardent deſire to maſter all its difficulties: if he relaxes in the purſuit, it is from the difficulties of the taſk, and the ſeduction of theories too little dependent on anatomy, and too eaſily acceſſible without its help. His deſire for real knowledge revives, only when the opportunity is loſt; when he is to leave the ſchools of medicine; when he is to give an account of his ſtudies, with an anxious and oppreſſed mind, conſcious of his ignorance in that branch which is to be received as the chief teſt of his profeſſional ſkill; or when, perhaps, he feels a more ſerious and manly impreſſion, the difficulty and importance of that art which he is called to practiſe.

Yet, in ſpite of feeling and reaſon, the ſtudent encourages in himſelf a taſte for ſpeculations and theories, the idle amuſements of the day, which even in his own ſhort courſe of ſtudy, he may obſerve ſinking in quick ſucceſſion into neglect and oblivion, never to revive; he aſpires to the character of a phyſiologiſt, to which want of

expe-

experience and a youthful fancy, have aſſigned a rank and importance which it does not hold in the eſtimation of thoſe who ſhould beſt know its weakneſs or ſtrength. The raweſt ſtudent, proud of his phyſiological knowledge, boaſts of a ſcience and a name which is modeſtly diſclaimed by the firſt anatomiſt, and the trueſt phyſiologiſt of this or any age: Dr. Hunter ſpeaks thus of his phyſiology, and of his anatomical demonſtration: "Phy-
" ſiology, as far as it is known or has been explained by
" Haller, and the beſt of the moderns, may be eaſily
" acquired by a ſtudent without a maſter, provided the
" ſtudent is acquainted with philoſophy and chemiſtry,
" and is an expert and ready anatomiſt; for with theſe
" qualifications he can read any phyſiological book, and
" underſtand it as faſt as he reads.

" In this age, when ſo much has been printed upon
" the ſubject, there is almoſt as little inducement to
" attend lectures upon phyſiology, as there would be
" for gentlemen to attend lectures upon government, or
" upon the hiſtory of England. Lectures upon ſubjects
" which are perfectly intelligible in print, cannot be of
" much uſe, except when given by ſome man of great
" abilities, who has laboured the ſubject, and who has
" made conſiderable improvements either in matter or
" in arrangement.

" In our branch, thoſe teachers who take but little
" pains to demonſtrate the parts of the body with pre-
" ciſion and clearneſs, but ſtudy to captivate young
" minds with ingenious ſpeculation, will not leave a re-
" putation that will outlive them half a century.

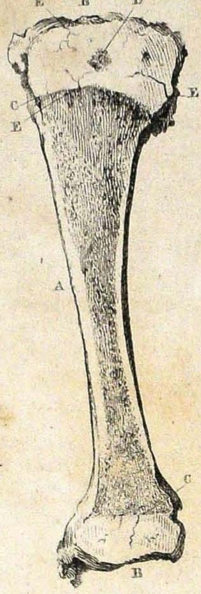
" I always have ſtudied, and ſhall continue my en-
" deavours, to employ the time that is given up to ana-
" tomical ſtudies as uſefully to the ſtudents as I can
" poſſibly make it—and therefore ſhall never aim at
" ſhowing what I know, but labour to ſhow and de-
" ſcribe, as clearly as poſſible, what they ought to know.
" This plan rejects all declamation, all parade, all
" wrangling, all ſubtility: to make a ſhow, and to ap-
" pear learned and ingenious in natural knowledge, may
" flatter vanity; to know facts, to ſeparate them from

" ſuppoſitions, to range and connect them, to make
" them plain to ordinary capacities, and above all, to
" point out the uſeful applications, is, in my opinion,
" much more laudable, and ſhall be the object of my
" ambition *."

* Introductory Lecture publiſhed by Dr. Hunter.

EDINBURGH, SEPT. 1793.

Fig. 1.



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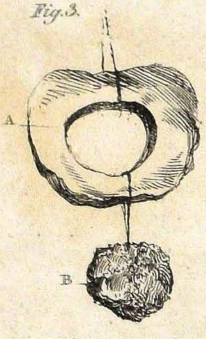

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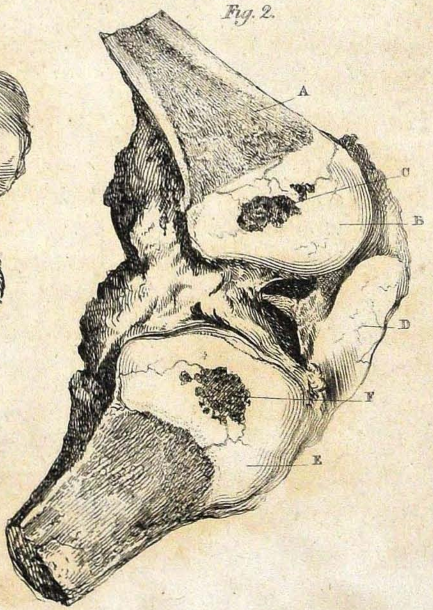

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EXPLANATION

OF

THE PLATES.

PLATE I.

This plate illuſtrates the deſcription of the manner in which oſſification takes place in cartilage.

Fig. 1.

THE tibia of the fœtus cut through after injection of the arteries.

A. The body of the bone, the centre of which is ſoft and very vaſcular.

BB. The cartilages, which are as yet in place of the heads of the bone.

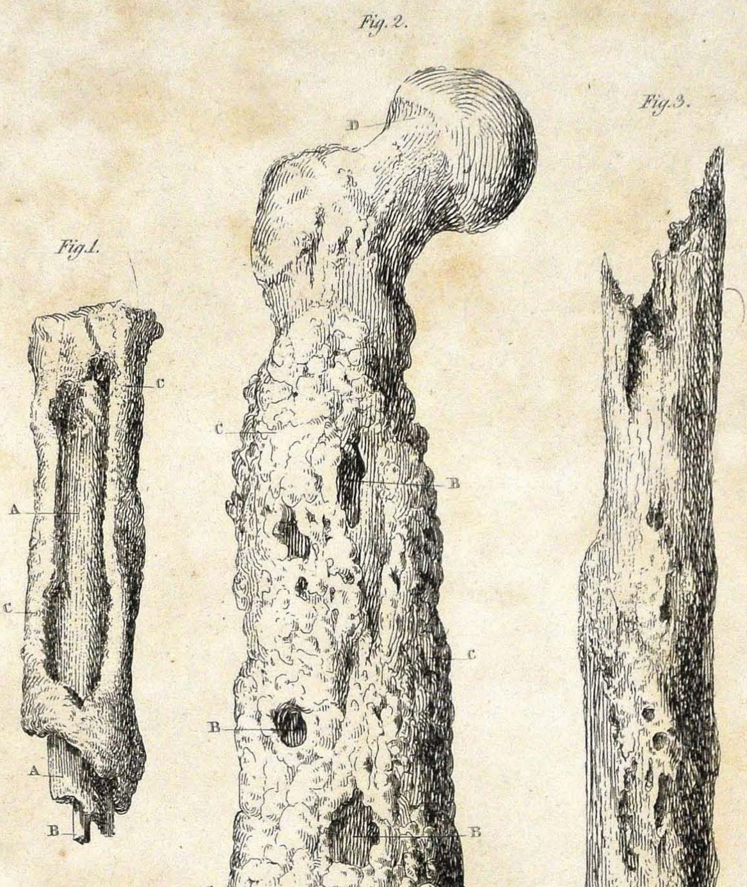
CC. Veſſels ſeen to penetrate the cartilage from the vaſcular extremity of the bone itſelf.

D. A central nucleus of bone forming in the cartilage.

EE. Veſſels penetrating from perichondrium into the cartilage: ſmall ſpecks of bony matter are ſeen to be formed by their extremities.

Fig. 2.

A ſection of the bones forming the knee joint of a child, ſhowing how the apophyſis is formed.



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out new matter, and ſtill continuing a ſource of irritation, killed the bone.

FIG. 2.

Example of the proceſs of necroſis in the human bone. This is the thigh bone of a ſtump remaining after amputation of the knee.

A. The old bone where it was ſawn through in operation.

BB. The old bone ſeen through the interſtices of the new bone.

CC. The new bone incloſing the old ſhaft.

D. The head of the bone in a natural ſtate.

The proceſs here was ſimilar to that in the experiment on the cock. The wound going wrong, a bad ſuppuration comes upon the ſtump, a waſting diſcharge comes from within the bone, the bone is inflamed; the diſeaſe of the marrow proceeds, the bone dies, but not till new bone has been formed around the old.

During ſuch a proceſs it is not wonderful that the continued irritation deſtroys the patient.

FIG. 3.

But ſometimes it happens that after theſe injuries are ſuſtained the old bone comes away as in this example; and the ſtump may yet do well.

EXPLANATION OF PLATE III.

This plate illuſtrates the chapter on the formation of the teeth.

FIG. I.

A tooth cut through and burnt.

A. The enamel not affected by the heat.

B. The body of the bone black.

C. The canal of the tooth, in which folely the fenfible nerve lies.

FIG. 2.

Shows the faccular pulp and rudiments of a tooth.

A. The pulp of the form of the tooth hanging out of its proper place.

B. The fac which contains the pulp and tooth, but being flit open they have fallen out of it.

C. The fhell of this bony part of the tooth which was formed on the pulp A.; but being a fecretion from it, and not connected otherways with it, it has fallen off.

FIG. 3. and 4.

The rudiments of a bony part of a tooth, when beginning to form on the projecting parts of the pulp.

FIG. 5.

A common example of a ball found in the centre of an elephant's tooth.

A. A part of the iron ball difcovered.

B B. Bone formed in circles round the tooth.

C. The common matter of the tooth.

D. Leffer nuclii of bone marking the irregular action of fecretion near the ball.

FIG. 6.

The bag containing the tooth and pulp, from the human fubject.

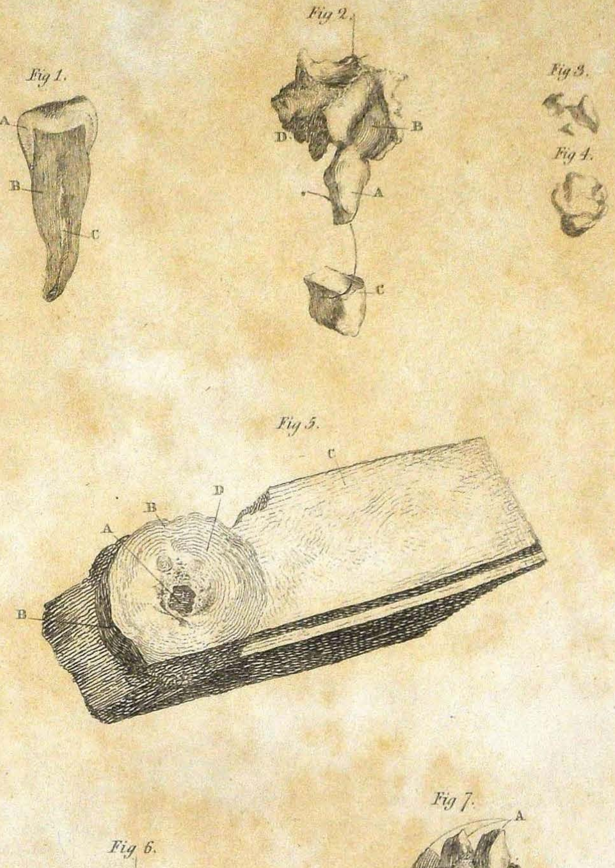
A. The bag, or facculus.

B. The lower part of the pulp when it can be feen without opening the fac.

C. The fac A contains the rudiments of the milk tooth, and here appended is already the rudiments of the fecond tooth.

FIG. 7.

Plate III.



Drawn & Etched by C. Bell.

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Fig. 7.

Section of the jaw of a child.

A. The incifores of the firft fet of teeth.

B. C. D. E. The rudiments of the eye tooth.

B. The pulp, having a connection with the facculus, and receiving arteries from the bone.

C. The foft pulp within the fac, and in *fitu*.

D. The connection of the facculus with the gum.

The bone of the tooth forming. — And now it will be perceived how it increafes: how fucceffive layers of bone are depofited by the pulp beneath; and how in due time the enamel is depofited upon the bone of the tooth by the fac which furrounds it.

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THE

ANATOMY

OF THE

BONES, MUSCLES, AND JOINTS.

THE

ANATOMY

OF THE

BONES, MUSCLES, AND JOINTS.

BOOK I.

OF THE BONES.

CHAP. I.

OF THE FORMATION AND GROWTH OF BONES.

IT is not eaſy to explain, in their natural order, the various parts of which the human body is compoſed; for they have that mutual dependence upon each other, that continual circle of action and reaction in their various functions, and that intricacy of connection, and cloſe dependence, in reſpect of the individual parts, that as in a circle there is no point of preference from which we ſhould begin to trace its courſe, there is in the human body no function ſo inſulated from the other functions, no part ſo independent of other parts, as to determine our choice. We cannot begin without heſitation, nor hope to proceed in any perfect courſe; yet, from whatever point we begin, we may ſo return to that point, as to repreſent truly this conſent of functions, and connection of parts, by which it is compoſed into one perfect whole.

The bones are framed as a basis for the whole system, fitted to support, defend, and contain the more delicate and noble organs. They are the most permanent, unchangeable parts of all the body. We see them exposed to the seasons, without suffering the smallest change; remaining for ages the memorials of the dead; the evidence of a former race of men exceeding ours in strength and stature; the only remains of creatures which no longer exist; the proofs of such changes on our globe, as we cannot trace but by these uncertain marks. Thus we are apt to conceive, that even in the living body, bones are hardly organized, scarcely partaking of life, not liable, like the soft parts, to disease and death. But minute anatomy, the most pleasing part of our science, unfolds and explains to us the internal structure of the bones; shows their myriads of vessels, and proves them to be as full of blood as the most succulent and fleshy parts; having, like them, their periods of growth and decay; as liable to accidents, and as subject to internal disease.

The phenomena of fractured bones first suggested some indistinct notions of the way in which bone might be formed. It was observed, that in very aged men, a hard crust was often formed upon the surface of the bones; that the fluid exuding into the joints of gouty people, sometimes coagulated into a chalky mass. Le Dran had seen in a case of spina ventosa, or scrophulous bone, an exudation which flowed out like wax, and hardened into perfect bone. Daventer had seen the juice exuding from a split in a bone, coagulate into a bony crust; and they thought it particularly well ascertained, that callus was but a coagulable juice, which might be seen exuding directly from the broken ends, and which gradually coagulated into hard bone. The best physiologists did not scruple to believe, that bones, and the callus of broken bones, were formed of a bony juice, which was deposited by the vessels of the part, and which passing, through all the successive conditions of a thin uncoagulated juice, of a transparent cartilage, and of soft and flexible bone, became

became at laſt, by a ſlow coagulation, a firm, hard, and perfect bone, depending but little upon veſſels or membranes, either for its generation or growth, or for nouriſhment in its perfect ſtate. But this coagulation is a property of dead matter, which has no place in the living ſyſtem; or if blood or mucus do coagulate within the body, it is only after they are ſeparated from the ſyſtem. Coagulation is a ſort of accident in the living body, and it is not to be believed that the accidental concourſe of parts ſhould form the perfect ſyſtem of a living bone; nor that coagulation, an irregular, uncertain proceſs, ſhould keep pace with the growth of the living parts; that a bone which is completely organized, and a regular part of the living ſyſtem, ſhould in all its progreſs towards this perfect ſtate, be mere inanimate, inorganized matter: Yet this opinion once prevailed; and if other theories were at that time propoſed, they did not vary in any very eſſential point from this firſt notion. De Heide, a ſurgeon of Amſterdam, believed that bone or callus were not formed from a coagulable juice, but from the blood itſelf. He broke the bones of animals, and, examining them at various points of time, he never failed (like other ſpeculators) to find exactly what he deſired to find. In "every experiment," he found a great effuſion of blood among the muſcles, and round the broken bone; and he as eaſily traced this blood through all the ſtages of its progreſs. In the firſt day red and fluid; by and by coagulated; then gradually becoming white, then cartilaginous, and at laſt (by the exhalation of its thinner parts) hardening into perfect bone.

It is very ſingular, that thoſe who abjure theory, and appeal to experiments, who profeſs only to deliver facts, are leaſt of all to be truſted; for it is theory which brings them to try experiments, and then the form and order, and even the reſult of ſuch experiments, muſt bend to meet the theories which they were deſigned to prove: It is by this deception that the au-

thors of two rival doctrines arrive at oppofite conclu-fions, by facts directly oppofed to each other. Du Hammel believed, that as the bark formed the wood of a tree, adding, by a fort of fecretion, fucceffive layers to its growth, the periofteum formed the bone at the firft, renewed it when fpoiled, or cut away, and, when broken, affumed the nature of bone, and repair-ed the breach. He broke the bones of pigeons, and, allowing them to heal, he found the periofteum to be the chief organ for re-producing bone. He found that the callus had no adhefion to the broken bone, was eafily feparated from the broken ends which remained rough and bare; and, in purfuing thefe diffections, he found the periofteum fairly glued to the external fur-face of the new bone; or he found rather the callus or regenerated bone to be but a mere thickening of the periofteum, its layers being feparated, and its fub-ftance fwelled. On the firft days he found the peri-ofteum thickened, inflamed, and eafily divided into many lamellæ, or plates; but while the periofteum was fuffering thefe changes, the bone was in no degree changed. On the following days, he found the tu-mor of the periofteum increafed at the place of the fracture, and extending further along the bone; its in-ternal furface already cartilaginous, and always tinged with a little blood, which came to it through the vef-fels of the marrow. He found the tumor of the peri-ofteum fpongy, and divifible into regular layers, while ftill the ends of the bone were unchanged, or only a little roughened by the firft layer of the periofteum be-ing already converted into earth, and depofited upon the furface of the bone: and in the next ftage of its progrefs, he found the periofteum firmly attached to the furface of the callous mafs. By wounding, not breaking the bones, he had a more flattering appearance ftill of a proof; for having pierced them with holes, he found the holes filled up with a fort of tompion, proceeding from the periofteum, which was thickened all round them. In an early ftage, this plug could, by drawing

drawing the periofteum, be pulled out from its hole: In a more advanced ftage, it was infeparably united to the bone fo as to fupply the lofs.

Haller, doubting whether the periofteum, a thin and delicate membrane, could form fo large a mafs of bone or callus, repeated the proofs, and he again found quite the reverfe of all this: That the callus, or the original bone, were in no degree dependent on the periofteum, but were generated from the internal veffels of the bone itfelf: That the periofteum did indeed appear as early as the cartilage which is to produce the bone, feeming to bound the cartilage, and give it form; but that the periofteum was at firft but a loofe tiffue of cellular fubftance, without the appearance of veffels, or any mark of blood, adhering chiefly to the heads or proceffes, while it hardly touched the body of the bone. He alfo found that the bone grew, became vafcular, had a free circulation of red blood, and that then only the veffels of the periofteum began to carry red blood, or to adhere to the bone. We know that the bones begin to form in fmall nuclæi, in the very centre of their cartilage, or in the very centre of the yet flexible callus, far from the furface, where they might be affifted by the periofteum.

Thus has the formation of bone been falfely attributed to a gelatinous effufion, gradually hardened; or to that blood which muft be poured out from the ruptured veffels round the fractured bone; or to the induration and change of the periofteum, depofiting layer after layer, till it completed the form of the bone.

But when, neglecting theory, we fet ourfelves to examine, with an unbiaffed judgment, the procefs of nature in forming the bones, as in the chick, or in reftoring them, as in broken limbs, a fucceffion of phenomena prefent themfelves, the moft orderly, beautiful, and fimple, of any that are recorded in the philofophy of the animal body: for if bones were but condenfed gluten, coagulated blood, or a mere depofition from the periofteum, they were then inorganized, and out of

of the ſyſtem, not ſubject to change, nor open to diſeaſe; liable, indeed, to be broken, but without any means of being healed again; while they are, in truth, as fully organized, as permeable to the blood, as eaſily hurt, and as eaſily healed, as ſenſible to pain *, and as regularly changed as the ſofter parts are. We are not to refer the generation and growth of bone to any one part. It is not formed by that gelly in which the bone is layed, nor by the blood which is circulating in it, nor by the perioſteum which covers it, nor by the medullary membrane with which it is lined; but the whole ſyſtem of the bone, of which theſe are parts only, is deſigned and planned, is laid out in the very elements of the body, and goes on to ripeneſs, by the concurring action of all its parts. The arteries, by a determined action, depoſite the bone; which is formed commonly in a bed of cartilage, as the bones of the leg or arm are; ſometimes betwixt two layers of membrane, like the bones of the ſkull, where true cartilage is never ſeen. Often the ſecretion of the bony matter is performed in a diſtinct bag, and there it grows into form, as in the teeth; for each tooth is formed in its little bag, which, by injection, can be filled and covered with veſſels. Any artery of the body may aſſume this action, and depoſite bone, which is formed alſo where it ſhould not be, in the tendons and in the joints, in the great arteries, and in their valves, in the fleſh of the heart itſelf, or even in the ſoft and pulpy ſubſtance of the brain.

In the human fœtus, and in other animals, before the time of birth, inſtead of bones, there are only cartilages of the form of the future bone. The whole fœtus appears to the eye like a mere gelly; the bones are a pure, almoſt tranſparent and tremulous gelly; they are flexible, ſo that a long bone can be bended into a

* The obſcurity on this ſubject is from the neglect of defined terms. We ſhall preſently ſee that the ſenſibility poſſeſſed by the bones, and the kind of pain to which they are ſubject, differs from the ſenſibility and pain of the ſkin and ſoft parts. C. B.

complete

complete ring; and no opacity, nor ſpot of oſſification is ſeen.

This cartilage never is hardened into bone; but, from the firſt, it is in itſelf an organized maſs. It has its veſſels, which are at firſt tranſparent, but which ſoon dilate; and whenever the red colour of the blood begins to appear in them, oſſification very quickly follows, the arteries being ſo far enlarged as to carry the coarſer parts of the blood. The firſt mark of oſſification is an artery, which is ſeen running into the centre of the gelly, in which the bone is to be formed. Other arteries ſoon appear, overtake the firſt, mix with it, and form a net work of veſſels; then a centre of oſſification begins, ſtretching its rays according to the length of the bone, and then the cartilage begins to grow opaque, yellow, brittle; it will no longer bend, and the ſmall nucleus of oſſification is felt in the centre of the bone, and, when touched with a ſharp point, is eaſily known by its gritty feel. Other points of oſſification are ſucceſſively formed; always the oſſification is foretold by the ſpreading of the artery, and by the arrival of red blood. Every point of oſſification has its little arteries, and each oſſifying nucleus has ſo little dependence on the cartilage in which it is formed, that it is held to it by veſſels only; and when the oſſifying cartilage is cut into thin ſlices, and ſteeped in water till its arteries rot, the nucleus of oſſification drops ſpontaneouſly from the cartilage, leaving the cartilage like a ring, with a ſmooth and regular hole where the bone lay.

The colour of each part of a bone is proportioned exactly to the degree in which its oſſification is advanced. When oſſification begins in the centre of the bone, redneſs alſo appears, indicating the preſence of thoſe veſſels by which the bony matter is to be poured out. When the bony matter begins to accumulate, the red colour of thoſe arteries is obſcured, the centre of the bone becomes yellow or white, and the colour removes towards the ends of the bone. In the centre, the firſt colouring of the bone is a cloudy, diffuſed and

general red, becauſe the veſſels are profuſe. Beyond that, at the edges of the firſt circle, the veſſels are more ſcattered and aſunder, diſtinct trunks are eaſily ſeen, forming a circle of radiated arteries, which point towards the heads of the bone. Beyond that, again, the cartilage is tranſparent and pure, as yet untouched with blood; the arteries have not reached it, and its oſſification is not begun. Thus, a long bone, while forming, ſeems to be divided into ſeven various coloured zones. The central point of moſt perfect oſſification is yellow and opaque. On either ſide of that, there is a zone of red. On either ſide of that, again, the veſſels, being more ſparſe, form a vaſcular zone, and the zone at either end is tranſparent or white *. The oſſification follows the veſſels, and buries and hides thoſe veſſels by which it is formed: The yellow and opaque part expands and ſpreads along the bone: The veſſels advance towards the heads of the bones: The whole body of the bone becomes opaque, and there is left only a ſmall vaſcular circle at either end; the heads are ſeparated from the body of the bone by a thin cartilage, and the veſſels of the centre, extending ſtill towards the extremities of the bone, perforate that cartilage, paſs into the head of the bone, and then its oſſification alſo begins, and a ſmall nucleus of oſſification is formed in its centre. Thus the heads and the

* It is curious to obſerve how completely vaſcular the bone of a chicken is before the oſſification have fairly begun; how the oſſification being begun, overtakes the arteries, and hides them, changing the tranſparent and vaſcular part of the bone into an opaque white; how, by peeling off the perioſteum, bloody dots are ſeen, which ſhow a living connection and commerce of veſſels betwixt the perioſteum and the bone; how by tearing up the outer layers of the tender bone, the vaſcularity of the inner layers is again expoſed; and the moſt beautiful proof of all is that of our common preparations, where, by filling with injection the arteries of an adult bone, by its nutritious veſſels, and then corroding the bone with mineral acids, we diſſolve the earth, leaving nothing but the tranſparent jelly, which reſtores it to its original cartilaginous ſtate; and then the veſſels appear in ſuch profuſion, that the bone may be compared in vaſcularity with the ſoft parts, and it is ſeen that its arteries were not annihilated, but its high vaſcularity only concealed by the depoſition of the bony parts.

body are, at the firſt, diſtinct bones formed apart, joined by a cartilage, and not united till the age of fifteen or twenty years.

The veſſels are ſeen entering in one large trunk (the nutritious artery) into the middle of the bone: From that centre they extend in a radiated form towards either end, and the fibres of the bone are radiated in the ſame direction; there are furrows betwixt the rays, and the arteries run along in the furrows of the bone, as if the arteries were forming theſe ridges, ſecreting and pouring out the bony matter, each artery piling it up on either ſide to form its ridge *. The body of the bone is ſupplied by its own veſſels; the heads of the bone are in part ſupplied by the extremities of the ſame trunks which perforate the dividing cartilage like a ſieve; the perioſteum adhering more firmly to the heads of the bone, brings aſſiſtant arteries from without, which meet the internal trunks, and aſſiſt the oſſification; which, with every help, is not accompliſhed in many years.

It is by the action of the veſſels that all the parts of the human body are formed, fluids and ſolids, each for its reſpective uſe: the blood is formed by the action of the veſſels, and all the fluids are in their turn formed from the blood. We ſee in the chick, where there is no external ſource from which its red blood can be derived, that red blood is formed within its own ſyſtem. Every animal ſyſtem, as it grows, aſſimulates its food, and converts it to the animal nature, and ſo increaſes the quantity of its red blood: and as the red blood is thus prepared by the actions of the greater ſyſtem, the actions of particular veſſels prepare various parts: ſome to be added to the maſs of ſolids, for the natural growth; others to ſupply the continual waſte; others to be diſcharged from the body as effete, and

* The arteries of a bone branch with freedom, and with the ſame ſeeming irregularity as in other parts of the body. The arteries do not exude their ſecretion from their ſides, ſo as to pile up the ridge of bone in their courſe. The ſecretion ſeems to be performed in their very extremities. C. B.

hurtful,

hurtful, or to allow new matter to be received; others again to perform certain offices within the body, as femen, faliva, bile, or urine. Thus the body is furnifhed with various apparatus for performing various offices, and for repairing the wafte. Thefe are the fecretions, and the formation of bone is one of thefe. The plan of the whole body lies in the embryo, in perfect order, with all its forms and parts. Cartilage is laid in the place of bone, and preferves its form for the future bone, with all its apparatus of furrounding membranes, its heads, its proceffes and its connection with the foft parts. The colourlefs arteries of this pellucid but organized mafs of cartilage keep it in growth, extend, and yet preferve its form, and gradually enlarging in their own diameter, at laft receive the entire blood *. Then the depofition of earthy matter begins. The bone is depofited in fpecks, which fpread and meet and form themfelves into perfect bone. While the bone is laid by arteries, the cartilage is conveyed away by the abforbing veffels; and while they convey away the fuperfluous cartilage, they model the bone into its due form, fhape out its cavities, cancelli, and holes, remove the thinner parts of the cartilage, and harden it into due confiftence.

If fuch organization of arteries to depofit bone, and abforbents to take up the cartilage, and make room for the offeous matter, be neceffary in the formation and growth, it is no lefs neceffary for the life and health of the full formed bone. Its health depends on the regular depofition and re-abforption, moulding and forming the parts; and by various degrees of action, bone is liable

* Previous to the formation of bone (or the preparation for it) in the cartilage, there is no proof of there being veffels in it. But we prefume, that the cartilage muft have veffels, becaufe it grows with the growth of the animal, previous to the formation of bone in it.

However, the change, previous to the depofition of bone, has not been noticed: the firm cartilage fuffers a change; there is a tract from the circumference to the centre of it, in which the firm cartilage is diffolved; and in the fpot where the firft particle of bone is to be depofited, there is a little foft well of matter, different from the firm fubftance of the cartilage. C. B.

to inflame, ulcerate, to rot and ſpoil, to become brittle by two much ſecreted earth, or to become ſoft by a greedy diſeaſed abſorption of its earthy parts. The earth, which conſtitutes the hardneſs, and all the uſeful properties of bone, is dead, inorganized, and lies in the interſtices of the bone, where it it is made up with mucus, to give it conſiſtence and ſtrength; furniſhed with abſorbents to keep it in health, and carry off its waſted parts; and pervaded by veſſels to ſupply it with new matter. The cartilage is in itſelf a ſecretion, to which the full ſecretion of bone ſucceeds, as the arteries grow ſtronger in their ſecreting office: for in a broken limb there is firſt a thin effuſion, then a tremulous gelly, then radiated veſſels, then oſſifying ſpots, and theſe running together form a perfect bone *. If the broken limb be too much moved during the cure, then are the ſecreting arteries interrupted in their office, perfect bone is never formed, it remains a cartilage, and an unnatural joint is produced; the veſſels are opened again, the proceſs is renewed, and the bones unite; or even by rubbing, by ſtimulating, by merely cutting the ſurrounding parts, the veſſels are made active, and their ſecretion is renewed. During all the proceſs of oſſification, the abſorbents proportion their action to the ſtimulus which is applied to them; they carry away the ſerous fluid, when gelly is to take its place; they remove the gelly, as the bone is laid; they continue removing the bony particles alſo, which (as in a circle) the arteries continually renew.

* The matter may be thus ſtated: the extravaſated blood being abſorbed, an effuſion is poured out by the veſſels of the broken bone. This matter is a regular ſecretion, it appears to the eye like a uniform jelly; but ſo does the embryo itſelf It is bone in embryo, the membranes and veſſels, arteries, veins, and abſorbents are in it; the arteries of the ſurrounding parts do not ſhoot into it, but veins, as well as arteries and abſorbents, inoſculate with the veſſels of this new formed matter; and whatever veſſels may, by accidental contact, inoſculate with this ſubſtance, whether coming from bone, muſcles, or membrane, ſtill bone is formed, becauſe it is the deſtined conſtitution of the new formed maſs, or rather, of the veſſels which are already in it to form bone. C. B.

Nothing

Nothing can be more curious than this continual renovation and change of parts, even in the hardeſt bones. We are accuſtomed to ſay of the whole body, that it is daily changed; that the older particles are removed, and new ones ſupply their place; that the body is not now the ſame individual body that it was; but it could not be eaſily believed that we ſpeak only by gueſs concerning the ſofter parts, what we know for certain of the bones. It was diſcovered by chance that animals fed upon the refuſe of the dyer's vats, received ſo much of the colouring matter into the ſyſtem, that the bones were tinged by the madder to a deep red, while the ſofter parts were unchanged; no tint remaining in the ligaments nor cartilages, membranes, veſſels, nor nerves, not even in the delicate veſſels of the eye. It was eaſy to diſtinguiſh by the microſcope, that ſuch colour was mixed with the bony matter, reſided in the interſtices only, but did not remain in the veſſels of the bone, which, like thoſe of all the body, had no tinge of red; while our injections again fill the veſſels of the bone, make all their branches red, but do not affect the colours of the bony part. When madder is given to animals, withheld for ſome time, and then given again, the colour appears in their bones, is removed, and appears again with ſuch a ſudden change as proves a rapidity of depoſition and abſorption, exceeding all likelihood or belief. All the bones are tinged in twenty-four hours; in two or three days their colour is very deep; and if the madder be left off but for a few days, the red colour is entirely removed.

This tinging of the bones with madder, was the great inſtrument in the hands of Du Hamel, for proving by demonſtration, that it was by layers from the perioſteum that the bone was formed; and how very far the mind is vitiated by this vanity of eſtabliſhing a doctrine on facts, is too eaſily ſeen here. Du Hamel, believing that the perioſteum depoſited ſucceſſive layers, which were added to the bone, it was his buſineſs to prove that the ſucceſſive layers would be depoſited alternately red, white, and red again, by giv-

ing a young animal madder, withholding it for a little while, and then beginning again to give it. Now, it is eaſy to foreſee that this tinging of the lamellæ ſhould correſpond with the ſucceſſive times in which the periosteum is able to depoſite the layers of its ſubſtance, but Du Hamel very thoughtleſsly makes his layers correſpond only with the weeks or months in which his madder was given or withheld. It is eaſy to foreſee alſo, that if madder be removed from the bones in a few days (which he himſelf has often told us), then his firſt layer, viz. of red bone, could not have waited for his layer of white to be laid above it, nor for a layer of red above that again, ſo that he ſhould have been able to ſhow ſucceſſive layers: And if madder can ſo penetrate as to tinge all the bones that are already formed, then, though there might be firſt a tinged bone, then a white and colourleſs layer, whenever he proceeded to give madder for tinging a third layer, it would pervade all the bone, tinge the layer below, and reduce the whole into one tint. If a bone ſhould increaſe by layers, thick enough to be viſible, and of a diſtinct tint, and ſuch layers be continually accumulated upon each other every week, what kind of a bone ſhould this grow to? Yet ſuch is the faſcinating nature of a theory, that Du Hamel, unmindful of any interruptions like thoſe, deſcribes boldly his ſucceſſive layers, carrying us through regular details, experiment after experiment, till at laſt he brings up his report to the amount of five ſucceſſive layers, viz. two red layers, and three white ones. And in one experiment he makes the tinge of the madder continue in the bones for ſix months, forming ſucceſſive layers of red and white, although in an earlier experiment (which he muſt have forgotten in his hurry) he tells us, that by looking through the tranſparent part of a cock's wing, he had ſeen the tinge of the madder gradually leave the bones in not many days.

Theſe experiments are as groſs and palpable as the occaſion of them, and ſhould ſtand as a warning to us, ſhewing how ſeverely and honeſtly we muſt queſtion our

our own judgment, when trying to confirm our preconceived theories by experiments and facts.

Yet, by these experiments with madder, one most important fact is proved to us; that the arteries and absorbents, acting in concert alternately deposite and re-absord the earthy particles, as fast as can be conceived of the soft parts, or even of the most moveable and fluctuating humours of the body. The absorption of the hardest bones is proved by daily observation; when a carious bone disappears before the integuments are opened; when a tumour, pressing upon a bone, destroys it; when an aneurism of the temporal artery destroys the skull; when an aneurism of the heart beats open the thorax, destroying the sternum and ribs; when an aneurism of the ham destroys the thigh bone, tibia, and joint of the knee; when a tumor coming from within the head, forces its way through the bones of the skull; — in all these cases, since the bone cannot be annihilated, what can happen, but that it must be absorbed and conveyed away? If we should need any stronger proofs than these, we have molities ossium, a disease by which, in a few months, the bony system is entirely broken up, and conveyed away, by a high action of the absorbents, with continual and deep-seated pain; a discharge of the earthy matter by the urine; a gradual softening of the bones, so that they bend under the weight of the body; the heels are turned up behind the head; the spine is crooked; the pelvis distorted; the breast crushed and bent in: and the functions beginning to fall low, the patient, after a slow hectic fever, long and much suffering of pain and misery, expires, with all the bones distorted in a shocking degree, gelatinous, or nearly so, robbed of all their earthy parts, and so thoroughly softened as to be cut with the knife.

Thus every bone has, like the soft parts, its arteries, veins, and absorbent vessels; and every bone has its nerves too. We see them entering into its substance in small threads, as on the surfaces of the frontal and parietal bones: We see them entering for parti-

cular purposes, by a large and peculiar hole, as the nerves which go into the jaws to reach the teeth: We find delicate nerves going into each bone along with its nutritious vessels; and yet we dare hardly believe the demonstration, since bones seem quite insensible and dead: We have no pain when the periosteum is rasped and scraped from a bone: We have no feeling when bones are cut in amputation; or when, in a broken limb, we cut off with pincers the protruding end of a bone: We feel no pain when a bone is trepanned, or when caustics are applied to it; and it has been always known, that the heated irons which the old surgeons used so much, made no other impression than to excite a particular titillation and heat, rather pleasant than painful, running along the course of the bone. But there is a deception in all this. A bone may be exquisitely sensible, and yet give no pain; a paradox which is very easily explained. A bone may feel acutely, and yet not send its sensation to the brain. It is not fit that parts should feel in this sense, which are so continually exposed to shocks and blows, and all the accidents of life; which have to suffer all the motions which the other parts require. In this sense, the bones, the cartilages, ligaments, bursæ, and all the parts that relate to joints, are quite insensible and dead. A bone does not feel, or its feelings are not conveyed to the brain: but, except in the absence of pain, it shews every mark of life. Scrape a bone, and its vessels bleed; cut or bore a bone, and its granulations sprout up; break a bone, and it will heal; or cut a piece of it away, and more bone will readily be produced; hurt it any way, and it inflames; burn it, and it dies: take any proof of sensibility, but the mere feeling of pain, and it will answer to the proof. In short, these parts have a sensibility which belongs to themselves, but have no feelings in correspondence with the general system *.

A bone

* From the consideration of these facts, together with this most essential one; that bones, ligaments, and tendons are actually capable

A bone feels ſtimuli, and is excited to re-act, injuries produce inflammation in the bones, as in the ſoft parts; and then ſwelling and ſpongy looſeneſs, and a fullneſs of blood, ſuppuration, ulcer, and the death and diſcharge of the diſeaſed bone enſue. When the texture of a bone is thus looſened by inflammation, its feeling is rouſed; and the hidden ſenſibility of the bone riſes up like a new property of its nature: and as the eye, the ſkin, and all feeling parts, have their ſenſibility increaſed by diſeaſe, the bones, ligaments, burſæ, and all the parts whoſe feeling during health, is obſcure and and hardly known, are rouſed to a degree of ſenſibility far ſurpaſſing the ſoft parts. The wound of a joint is indeed leſs painful at firſt, but when the inflammation comes, its ſenſibility is raiſed to a dreadful degree: the patient cries out with anguiſh. No pains are equal to thoſe which belong to the bones and joints.

This oſſification is a proceſs of a truly animal nature: no coagulation will harden cartilage into bone; no change of conſiſtence will form the blood into it; no condenſation of the perioſteum can aſſimilate it to

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capable of receiving and propagating painful impreſſions to the ſenſorium; I have come to the following concluſion:—The ſenſation of pain is beſtowed as a ſafeguard to the frame, forcing us to avoid whatever is hurtful. To this effect, ſenſibility varies in different parts, and in general the ſenſibility of the more ſuperficial parts, being ſufficient protection to the parts beneath, the deep parts are but little ſenſible. The ſenſibility poſſeſſed by the ſkin would not be ſufficient protection to the eye; ſuch parts differ in kind of ſenſibility as well as in degree. Experiments have been made by cutting and burning the bones and tendons, and the concluſion has been, that they were inſenſible. But when a man ſprains his ankle joint, he is in extreme pain, though he can eaſily ſatisfy himſelf that the pain he feels is not in the ſkin, but muſt be in the joint and tendons. It appears then, that ſuch parts uſually thought inſenſible feel pain, and can propagate that pain to the ſenſorium; and further, that the peculiar ſenſibilities are exactly ſuch, as to allow of free and natural motion and of the neceſſary degree of attrition, but are beſtowed for the purpoſe of making us avoid that degree of violence, which would endanger the texture or healthy function of the part. C. B.

no

the nature of a bone. Bone is not the inorganic concrete which it was once ſuppoſed, but is a regularly organized part; whoſe form ſubſiſts from the firſt, which is perfected by its ſecreting arteries, balanced, as in every ſecretion, by the abſorbents of the part; it lives, grows and feels, is liable to accidents, and ſubject to diſeaſe. It is a proceſs which, at firſt, appears ſo rapid, that we ſhould expect it to be ſoon complete; but it becomes in the end a ſlow and difficult proceſs. It is rapid at firſt; it advances ſlowly after birth; it is not completed till the twentieth year; it is forwarded by health and ſtrength, retarded by weakneſs and diſeaſe. In ſcrophula it is imperfect; and ſo children become rickety, when the bones ſoften and ſwell at their heads, and bend under the weight of the body. And why ſhould we be ſurpriſed, that careleſſneſs of food or clothing, bad air, or languid health, ſhould cauſe that dreadful diſeaſe, when more or leſs heat, during the incubation of a chick, prevents the growth of its bones; when the ſickneſs of a creature, during our experiments, protracts the growth of callus; when, in the accidents of pregnancy, of profuſe ſuppuration, or of languid health, the knitting of broken bones is delayed, or prevented quite?

This proceſs, ſo difficult and ſlow, is aſſiſted by every proviſion of nature. The progreſs of the whole is ſlow, that ſo long as the body increaſes in ſtature, the bones alſo may grow; but it is aſſiſted in the individual parts, where ſome are ſlow, ſome rapid in their growth, ſome delayed, as the heads of joints, that their bones may be allowed to extend, and others haſtened, as the pelvis, that it may acquire its perfect ſize early in life. Oſſification is aſſiſted by the ſoftneſs of the cartilaginous bed in which the bone is formed; by thoſe large and permeable veſſels which carry eaſily the groſſer parts of the blood; by a quick and powerful abſorption, which all along is modelling the bone; and, moſt of all, by being formed in detached points, multiplied and crowded together, wherever much bone is required.

 There

There is one central ring firſt oſſified in a long bone, as of the leg or arm; the heads or ends of the bone are at firſt mere cartilage, but they alſo ſoon begin to oſſify; the body ſtretches in a radiated form towards either head; the heads oſſifying each in its centre, alſo ſtretch towards the bone; the heads meet the body, and join to it; a thin cartilage only is interpoſed, which grows gradually thinner till the twentieth year, and then diſappears, the body, heads, and proceſſes, becoming one bone. In flat bones, as in the ſkull, oſſification goes from one or more central points, and the radiated fibres meet the radii of other oſſifying points, or meet the edges of the next bone. The thick round bones which form the wriſt and foot, have one oſſification in their centre, which is bounded by cartilage all round. The proceſſes are often diſtinct oſſifications joined to the bones, like their heads, and ſlowly conſolidated with them into firm bones *.

While the bone is forming, various parts, eſſential to its ſyſtem, gradually riſe into view. At firſt, we cannot in the long bone perceive any heads, proceſſes, cavities, or cells; theſe parts are very ſlowly formed, and are perfected only in the adult bone.

At firſt, the whole length of a long bone, is repreſented by a tranſparent gelly, where there is no diſtinction of heads nor proceſſes; it is all of one maſs. After the red blood has begun to tinge this cartilage, the oſſification begins, and one ring is formed in the middle of the bone: from this ring, the fibres ſtretch towards either end, and ſtop there; then it begins to appear that the heads and body are diſtinct parts; the fibres of the growing bone have extended till the cartilage is annihilated, and only a ſmall plate remains, ſeparating the knobs of the heads from the long body of the bone. Thus there is no diſtinction betwixt the heads and the body, while the heads are cartilaginous;

* The proceſſes and heads are named the epiphyſis and apophyſis of bones.

they

they begin to appear, as diſtinct parts, at that ſtage in which the body of the bone is oſſified, and each of the heads is beginning to form; they continue three diſtinct bones, during all the early part of life, and are eaſily ſeparated, by ſoaking the bone in water; when they are ſeparated, there is ſeen a rough hollow, on the ſurface of the epiphiſis, or ſeparated head, and a rough convexity on the end of the body: they are finally united into one bone, about the twentieth year.

In the original cartilage, there is no hollow, nor cavity; it is all one ſolid maſs. When the oſſification firſt appears, the cavity of the bone alſo begins, and extends with the oſſification: at firſt the cavity is confined chiefly to the middle of the bone, and extends very ſlowly towards the ends. This cavity, in the centre of the bone is at firſt ſmooth, covered with an internal membrane, containing the trunks and branchings of the nutritious veſſels, which enter by a great hole, in the middle of the bone; and the cavity is traverſed, with diviſions of its lining membrane, which, like a net work of partitions, conduct its branches to all parts of the internal ſurface of the bone; and its nets, or meſhes, are filled with a reddiſh and ſerous fluid, in the young bone, but ſecrete and contain a perfect marrow in the adult bone.

The whole ſubſtance of a bone is not only fibrous, as appears outwardly, but is truly lamellated, conſiſting of many diſtinct and delicate plates of bone, which lie over each other, in regular order, and might ſuggeſt the notion of ſucceſſive oſſifications of the perioſteum forming the bone. Theſe lamellæ, or plates, are more condenſed and firm, towards the outer ſurface, and are more looſe, ſeparate, and ſpongy, towards the internal ſurface of the bone; and it is eaſily ſeen, during the growth of a young bone, that the inner and more delicate plates, are ſeparating from the walls of the bone, and receding towards its cavity: and theſe plates, being again croſſed by ſmall bony partitions, form a net work, or ſpongy maſs, which fills the whole cavity of the bone.

In the middle of the bone, the cavity is ſmall, the walls thick, and having all their bony plates; the cells of net work few, and large; but towards the ends, the bone ſwells out, the cavity alſo is large; but it is not like that in the middle, a large tubular cavity: it is ſo croſſed with lattice-work, with ſmall interſtices and cells, that it ſeems all one ſpongy maſs of bone; and ſo many of the inner layers are ſeparated, to form this profuſion of cells, that the whole ſubſtance of the bone has degenerated into this lattice-work, leaving only a thin outward ſhell *. This reticular form is what anatomiſts calls the cancelli, lattice-work, net-work, or alveolar part of the bone; it is all lined with one delicate membrane, and inward partitions of the ſame lining membrane cover each diviſion of the lattice-work, forming each cell into a diſtinct cavity. In theſe cavities, or cells, the marrow is ſecreted. The ſecretion is thin and bloody in children; it thickens as we advance in years; it is a ſolid oil, or marrow in the adult. The marrow is firmer, and more perfect in the middle of the bone, and more thin and ſerous towards the ſpongy ends. The whole maſs, when ſhaken out of the bone, is like a bunch of grapes, each hanging by its ſtalk. The globules, when ſeen with the microſcope, are neat, round and, white, ſeeming like ſmall pearls, and each ſtalk is ſeen to be a ſmall artery, which comes along the membrane of the cancelli, ſpreads its branches beautifully on the ſurface of the bag, and ſerves to ſecrete the marrow, each ſmall twig of artery, filling its peculiar cell. To this, an old anatomiſt added, that they had their contractile power, like the urinary bladder, for expelling their contents; that they ſqueezed their marrow, by channels of communication, through and among the bony layers; and

* That it is merely an expanſion of the layers that forms the cancelli, and a mere ſwelling and ſpongineſs of the ſame quantity of bony ſubſtance, that makes the ends ſo much thicker than the middle, is proved by this, that an inch of the ſmaller bony tube, cut from the middle, weighs equally with an inch of the large ſpongy tube, cut out from the ends.

that

that their oil exuded into the joint, by nearly the ſame mechaniſm, by which it got into the ſubſtance of the bone.

While the conſtitution of a bone was not at all underſtood, anatomiſts noted with particular care, every trifling peculiarity, in the forms or connections of its parts, and theſe lamellæ attracted particular notice. That a bone is formed in ſucceſſive plates, is eaſily ſeen, as in whale-bone; or in the horns and bones of the larger animals; in church-yard bones, which have been long buried, or long expoſed to the air. It is demonſtrated by a careful picking, and ſeparation of the ſcales, in a young bone, or by burning a bone, which melts and conſumes its gelly, and leaves the bony parts entire. It is ſeen in the common diſeaſes of bones; for they caſt off by ſucceſſive plates, or leaves, whence the proceſs is named exfoliation; and one plate is thoroughly ſpoiled and caſt off, while another is entire, and ſound. Malphighi, had firſt obſerved the lamellated ſtructure of bones, likening them to the leaves of a book. Gagliardi, who like Hippocrates, went among the burial-places of the city, to obſerve the bones there, found in a tomb, where the bones had been long expoſed, a ſkull, the os frontis of which he could diſſect into many layers, with the point of a pin *. He afterwards found various bones, from all parts of the body, thus decompoſed; and he added to the doctrine of plates, that

* Notwithſtanding what is here delivered, there is no proof of the bones being lamellated; as to the exfoliation of bone, the dead portion is more generally irregular in its thickneſs, and rugged on its inner ſurface. This exfoliation of bone, is a proceſs of the living bone, and the inner living ſurface recedes from the outer one, becauſe that outer ſurface is injured or dead. The nature of the injury, or the depth to which the bone has become dead, determines the extent and form of the portion caſt off. When a ſcale only is thrown off, it is becauſe the bone is only dead upon the ſurface. In regard to the breaking up of the ſurface of the cranial bones, when they lie expoſed, the ſcales are ſimilar to thoſe from ſtones or metals expoſed to the influence of the air, and moiſture, and varying temperature: the thickneſs and ſucceſſion of exfoliations, depends on the operation of the weather, not on the original formation of the bone. I have never ſeen heat produce a lamellated decompoſition of bone. C. B.

they were held together by minute proceſſes, which, going from plate to plate, performed the offices of nails: Theſe appeared to his imagination to be of four kinds, ſtraight and inclined nails, crooked or hook-like, and ſome with ſmall round heads, of the forms of bolts or pins*.

Another notable diſcovery, was the uſe of the holes which are very eaſily ſeen through the ſubſtance of bones, and among their plates. They are, indeed, no more than the ways by which the veſſels paſs into the bones; but the older anatomiſts imagined them to be ſtill more important, allowing the marrow to tranſude through all the ſubſtance of the bone, and keep it ſoft. Now this notion, of lubricating the earthy parts of a bone, like the common talk of fomentations to the internal parts of the body, is very mechanical, and very ignorant; for the internal parts of the body, are both hot and moiſt of themſelves, and neither heat nor moiſture can reach them from without: the bone is already fully watered with arteries; it is moiſt in itſelf, and cannot be further moiſtened nor lubricated, unleſs by a fuller and quicker circulation of its blood. It muſt be preſerved by that moiſture only which exiſts in its ſubſtance, and muſt depend for its conſiſtence upon its own conſtitution; upon the due mixing up of its gluten and earth. Every part is preſerved in its due conſiſtence by the veſſels which form its ſubſiſtence; and I ſhould no more ſuppoſe fat neceſſary for preſerving the moiſtneſs of a bone, than for preventing brittleneſs in the eye. This marrow is, perhaps, more an accidental depoſition, than we, at firſt ſight, believe. We indeed find in it ſuch a regularity of ſtructure, as ſeems to indicate ſome very particular uſe; but we find the ſame ſtructure exactly in the common fat of the body. When, as we advance in years, more fat is depoſited in the omentum, or round the heart, we cannot entertain the abſurd notion, of fat being

* Theſe nails, which Gagliardi imagined were no more than the little irregularities, riſings, and hollows, of the adjoining plates, by which they are connected.

needed

needed in our old age, to lubricate the bowels or the heart ; no more is the marrow (which is not found in the child), accumulated in old age, for preventing brittleneſs of the bones*.

The blood veſſels of a bone are large, in proportion to the maſs of the bone. For firſt one great trunk enters commonly about the middle of the bone, as in the thigh bone, leg or arm, and it is called the nutritious or medullary artery : it goes in the central cavity of the bone, ſpreads upwards and downwards, ſupplies all the ſubſtance of the bone itſelf, and gives thoſe delicate arteries which ſecrete the marrow. Other arteries enter from without, at the ſpongy ends of the bones, where the holes are not viſible only, but very large in the adult ; particularly large arteries enter into the heads of the bones, as of the ſhoulder, or of the thigh bones ; and there the perioſteum adheres very ſtrongly ; and every where on its ſurface the bone is ſupplied by numerous veſſels from the perioſteum (and this ſeems, indeed, to be the chief uſe of that membrane) ſo that in tearing off the perioſteum, the ſurface of the membrane, and of the bone, are ſeen covered with bloody points ; all the veſſels are conducted to the ſubſtance of the bone by its two membranes : the internal veſſels by the membrane which lines the cavity, and which is known by the abſurd name of internal perioſteum ; the external one by the outer membrane, the proper or external perioſteum.

* If we look to the difference there is in the adipoſe membrane, we ſhall find it more apparent than real. The fat on the ſoles of the feet and palms of the hands is particularly firm, but this firmneſs reſults from the ſtrong intertexture of filaments of a tendinous ſtrength. The fat in the expoſed parts of the limbs is leſs firm, in the orbits of the eyes more delicate, but in the bones it lies in tranſparent membranes, and is quite ſoft and compreſſible. The difference, however, is only in the manner in which the bags containing the fat are bound up and protected ; where the ſubſtance is expoſed to preſſure, it is firm, where it lies concealed, it is leſs ſo, but where it is altogether within the protection of the bones, the membranes are very delicate, and the fat takes the appearance of marrow. C. B.

 The

The internal perioſteum is that membrane which ſurrounds the marrow, and in the bags of which the marrow is formed and contained. It is more connected with the fat, than with the bone ; and in animals, can be drawn out entire from the cavity of the bone : but its chief uſe is to conduct the veſſels which are to enter into the ſubſtance of the bone ; and this connection and office is ſo eſſential to the life and health of the bone, that the ſpina ventoſa, or ſcrophulous bone, is merely a failure of the internal circulation, a total corruption of the marrow, and a conſequent loſs of the medullary veſſels ; by which the whole bone dies, is thrown out by nature, or oftener the limb muſt be cut off. The ſame effect is produced in our experiments, where, by piercing into the medullary cavity, and deſtroying the marrow, the ſhaft of the bone dies, while the heads and proceſſes live, only becauſe they are ſupplied more fully by their external veſſels.

The perioſteum, which was once referred to the dura mater, is merely condenſed cellular ſubſtance ; of which kind of matter we now trace many varied forms and uſes ; for, ſo cloſe is the connection of the perioſteum, tendons, ligaments, faſciæ, and burſæ, and ſo much are theſe parts alike in their nature and properties, that we reckon them but as varied forms of one common ſubſtance, ſerving for various uſes in different parts. The perioſteum conſiſts of many layers, accumulated and condenſed one above another : it adheres to the body of the bone by ſmall points or proceſſes, which dive into the ſubſtance of the outer layer, giving a firm adheſion to it, ſo as to bear the pulling of the great tendons, which are fixed rather into the perioſteum, than into the bone. It is alſo connected with the bone, by innumerable veſſels. The layers of the perioſteum neareſt to the bone, are condenſed and ſtrong, and take a ſtrong adheſion to the bone, that the veſſels may be tranſmitted ſafe, and the fibres of this inner layer follow the longitudinal directions of the bony fibres. The perioſteum is looſer in its tex-

ture outwardly, where it is reticulated and lax, changing imperceptibly into the common cellular ſubſtance. There the fibres of the perioſteum aſſume the directions of the muſcles, tendons, or other parts which run over it. The perioſteum is not for generating bone; and therefore it adheres but ſlightly to the growing bone: it is for nouriſhing the external plates; and therefore as the bone grows, and as the external plates are further removed from the medullary veſſels, the adheſion of the perioſteum becomes cloſer, its arteries are enlarged, and the dependence of the outer layers on the perioſteum is as well proved as the dependence of the body of the bone upon its medullary artery; for as piercing the medulla kills the whole bone, hurting the perioſteum kills the outer layers of the bone. Any accident which ſpoils the bone of its perioſteum has this effect; the accidental wounds of the perioſteum, deep ulcers of the ſoft parts, as on the ſhin, the beating of aneuriſms, the growth of tumors, the preſſure even of any external body, will, by hurting the perioſteum, cauſe exfoliation, which is, in plain terms, the death of the external layer, by the injury of the outward veſſels; and an active inflammation of the deeper layers, which being fully nouriſhed by the internal arteries, inflame, ſwell, become porous and ſpongy, form granulations, and theſe granulations puſh off the mortified plate, and form themſelves into new bone, which ſupplies its place*.

The cartilages are alſo a part of the living ſyſtem of the bone: and we ſee too well, in the queſtion of the bones themſelves, how unphiloſophical it muſt be, to deny organization and feeling to any part of the living body, however dead or inſulated it may appear; for every part has its degree of life: the eye, the ſkin, the fleſh, the tendons, and the bones, have ſucceſſive degrees of feeling and circulation. We ſee, that where

* It is the injury to the ſurface of the bone which cauſes the exfoliation, not the loſs of veſſels by the ſeparation of the perioſteum; and when the bone dies, as in necroſis, from the injury to the marrow, inflammation precedes the death. C. B.

even

even the loweſt of theſe the bone is deprived of its ſmall portion of life, it becomes a foreign body, and is thrown off from the healthy parts, as a gangrened limb is ſeparated from the ſound body ; and we ſpeak as familiarly of the death of a bone, as of the gangrene of ſoft parts. How, then, ſhould we deny organization and life to the cartilages ? though ſurely, in reſpect of feeling, they muſt ſtand in the very laſt degree.

The perioſteum goes from the bone over the ſurface of the cartilage alſo, where it is named perichondrium : It ſtill preſerves its own vaſcular nature ; the veſſels can be injected ; and it is not to be believed that the perichondrium has theſe veſſels, without communicating them to the cartilage to which it belongs. We ſee red arteries in the centre of an oſſifying cartilage, and therefore we know that the trunk of the artery may be red, as in the oſſifying part of the cartilage, and yet the extremity of the ſame artery be pellucid, as in the unoſſified part. Since veſſels run through the cartilage to generate bone, we cannot, in reaſon, ſuppoſe that theſe veſſels are produced in the inſtant in which they appear : they had exiſted before ; they are but dilated now ; the increaſing action dilates them, and the dilatation makes them red ; this enables them to ſecrete bone, and, in many caſes, as in the accidental joint formed by a fracture ill cared for, we can, by paring the cartilage, ſet the veſſels free again, and make them begin to ſecrete.

Wherever we find a vaſcular membrane ſurrounding and nouriſhing any part, as the vitreous or cryſtalline humours in the eye, we muſt not ſuppoſe that ſuch are inſulated parts, maintained there by mere adheſion ; but muſt conſider them as parts regularly organized, their vaſcular membrane being part of their living ſyſtem ; and though the tranſparent humours of the eye, the cartilages and ligaments over all the body, and all the ſyſtem of the bones, have been conſidered as mere concretes, and inſulated parts, they are now known to be regular parts of the living whole. The cartilages have no very active circulation ; it is ſuch

ſuch as to keep them in life, but not ſo active as to endanger inflammation, in the continual ſhocks which they muſt endure; their feeling muſt be very obſcure, for feeling alſo would have been inconſiſtent with their offices, which is to cover and defend the bones; to yield to the weight of the body, and to reſtore themſelves when that weight is removed; to bear all the ſhocks of leaps or falls; to perform all the motions of the body, and the continual workings of the joints, where they rub, and even crackle upon each other without danger or pain.

We now underſtand the conſtitution of a bone, and can compare it fairly with the ſoft parts in vaſcularity, and in feeling; in quickneſs of abſorption; in the regular ſuppy of blood neceſſary to the life of the bony ſyſtem; in the certain death of a bone, when deprived of blood by any injury of its marrow, or of its perioſteum, as a limb dies of gangrene, when its arteries are cut or tied; in the continual action of its abſorbents, forming its cavity, ſharping its proceſſes and heads, keeping it ſound and in good health, and regulating the degree of bony matter, that the compoſition may neither be too brittle nor too ſoft. From this conſtitution of a bone, we could eaſily foreſee how the callus for uniting broken bones muſt be formed; not by a mere coagulation of extravaſated juice, but by a new organization reſembling the original bone.

The primordium of all the parts of the body is a thin gelatinous mucus, in which the forms of the parts are laid; and the preparation for healing wounds, and for every new part that needs to be formed, is a ſecretion of mucus which is ſoon animated by veſſels coming into it from every point. In every external wound, in every internal inflammation, wherever external parts are to be healed, or internal viſcera are about to adhere, a mucous matter is ſecreted, which ſerves as a bed or nidus, in which the veſſels ſpread from point to point, till the mucus is animalized and converted into a membrane: and thus the heart, the inteſtines, the teſticle, and other parts, adhere by inflammation

inflammation to the coats which furround them, and which are naturally loofe. It is a mucus of the fame form which unites the ends of a broken bone; and, by breaking the bones of animals, and attending to the progrefs of the callus, we find firft a thin mucus; then that thickened into a tranfparent gelly; that gelly growing vafcular, and thefe veffels gradually depofiting nuclæi of offification in the centre of the mafs; and by madder or by fine injections, we can make the gelly appear vafcular, and make the nuclæi of offification quite red. The colours of our injections begin to tinge the cartilage as it begins to offify, and as foon as the offification is general, it receives a general tinge.

When we find the fubftance of the oldeft bone thus full of veffels, why fhould we doubt its being able, from its own peculiar veffels, to heal a breach, or to repair any lofs? We have no reafon to refer the generation of callus to the marrow, to the periofteum, nor to the fubftance of the bone itfelf, for they are but parts of the common fyftem of a bone; and each part of this fyftem is of itfelf capable of regenerating the whole. How little the conftitution of a bone has been underftood, we may know from the ftrange debates which have fubfifted fo long about the proper organ for generating callus. Some have pronounced it to be the periofteum; others the medullary veffel, and internal membrane; others the fubftance of the bone itfelf: but I have been employed in explaining, that not not only part of the bone, periofteum, or marrow, but even any artery in all the fyftem, may affume that action which generates bone. In the heat of this difpute, one of the moft eminent anatomifts produced a difeafed bone, where a new bone was formed furrounding a carious one, and the fpoiled bone rattled within the cavity of the found one: here we fhould have been ready to pronounce, that bone could be formed by the periofteum only. But prefently another anatomift produced the very reverfe, viz. a found young bone, forming in the hollow cylinder of a bone which

which had been long dead; where, of courſe, the callous mattter muſt have been poured into the empty cavity of the ſpoiled bone, from the ends which ſtill remained ſound, or muſt have been ſecreted by the medullary veſſels. But the truth is, that callus may be thus produced from any part of the ſyſtem of a bone; from its perioſteum, from its medulla, or from the ſubſtance of the bone itſelf *. If we pierce the bone of any animal, and deſtroy the marrow, the old bone dies, and a new one is formed from the perioſteum: if we kill the creature early, we find the new bone to be a mere ſecretion from the inner ſurface of the perioſteum; and if we wait the completion of the proceſs, we find the new bone beautiful, white, eaſily injected, and thick, looſe in its texture, and vaſcular and bloody, but ſtill firm enough for the animal to walk upon; and in the heart of it, we find the old bone dead and black. If we reverſe this operation, and deſtroy the perioſteum only, leaving the nutritious veſſels entire, then the new bone is formed freſh and vaſcular by the medullary veſſels, and the old one quite black and dead, ſurrounds it; and in fractures of the patella or knee-pan, where there are no medullary veſſels, the pieces are united by a callus, which is ſecreted from the veſſels of the bone itſelf.

The diſeaſes of the bones are the moſt frequent in ſurgery; and it is impoſſible to expreſs how much the ſurgeon is concerned in obtaining true ideas of the ſtructure, conſtitution, and diſeaſes of bones; how tedious, how painful, and how loathſome they are; how often the patient muſt loſe his limb, or endanger his life; how very uſeful art is; but above all, what wonders nature daily performs in recovering bones from their diſeaſed ſtate.

* The term, ſyſtem of a bone, is incorrect, if by it is meant the perioſteum which ſurrounds the bone, and the marrow within. In the experiments and obſervations which I have made, neither the perioſteum or marrow ſeemed to form the bone; and I conclude, that nothing but bone can form bone, by the continuation of natural actions; and that in the caſe of *necroſis*, the old bone inflames and begins the new formation, before the continued irritation in the centre kills it. C. B.

CHAP.

CHAP. II.

OF THE SKULL IN GENERAL — THE BONES OF WHICH IT IS COMPOSED — THEIR TABLES — DIPLOE — SUTURES — THEIR ORIGINAL CONDITION, AND THEIR PERFECT FORM, REPRESENTED AND EXPLAINED.

WHILE the bones in general ſerve as a baſis for the ſoft parts, and ſupporting and directing the motions of the body, certain bones have a higher uſe in containing thoſe organs whoſe offices are the moſt eſſential to life. The ſkull defends the brain; the ribs and ſternum defend the heart and lungs; the ſpine contains that prolongation of the brain which gives out nerves to all the body: and the injuries of each of theſe are important in proportion to the value of thoſe parts which they contain.

How much the ſtudent is intereſted in obtaining a correct and perfect knowledge of the ſkull, he muſt learn by ſlow degrees. For the anatomy of the ſkull is not important in itſelf only; it provides for a more accurate knowledge of the brain; explains, in ſome degree, the organs of ſenſe; inſtructs us in all thoſe accidents of the head which are ſo often fatal, and ſo often require the boldeſt of all our operations. The marks which we take of the ſkull, record the entrance of arteries; the exit of veins and nerves; the places and uſes of thoſe muſcles which move the jaws, the throat, the ſpine. Indeed in all the human body, there is not found ſo complicated and difficult a ſtudy as this anatomy of the head; and if this fatiguing ſtudy can be at all relieved, it muſt be by firſt eſtabliſhing a very regular and orderly demonſtration of the ſkull.

For this end, we diſtinguiſh the face, where the irregular ſurface is compoſed of many ſmall bones, from

the cranium or ſkull-cap, where a few broad and flat-ſhaped bones form the covering of the brain. It is theſe chiefly which incloſe and defend the brain, which are expoſed to injuries, and are the ſubject of operation. It is theſe alſo that tranſmit the nerves: ſo that the cranium is equally the object of attention with the anatomiſt and with the ſurgeon.

All the bones of the cranium, are of a flattened form, conſiſting of two tables, and an intermediate diploe, which anſwers to the cancelli of other bones. The tables of the ſkull, are two flat and even plates of bone: the external is thought to be thicker, more ſpongy, leſs eaſily broken; the inner table, again, is denſe, thin, and brittle, very eaſily broken, and is ſometimes fractured, while the external table remains entire: thence it is named tabula vitrea, or the glaſſy table. Theſe tables are parted from each other by the diſtance of a few lines *; and this ſpace is filled up with the diploe, or cancelli. The cancelli, or lattice work, is a net of membranes, covered with veſſels, partly for ſecreting marrow, and partly for nouriſhing the bone; and by the dura mater adhering to the internal ſurface, and ſending in arteries, which enter into the cancelli by paſſing through the ſubſtance of the bone, and by the pericranium covering the external plate, and giving veſſels from without, which alſo enter into the bone, the whole is connected into one ſyſtem of veſſels. The pericranium, dura mater, and ſkull depend ſo entirely, one upon the other, and are ſo fairly parts of the ſame ſyſtem of veſſels, that an injury of the pericranium ſpoils the bone, ſeparates the dura mater, and cauſes effuſion upon the brain: a ſeparation of the dura mater is, in like manner followed by ſeparation of the pericranium which had been found and unhurt; and every diſeaſe of the cancelli, or ſubſtance of the bone is communicated both ways; inward

* In anatomy, there is occaſion in almoſt every deſcription, for a ſcale of ſmaller parts. The French divide their inch into twelve parts, each of which is a line. The French line, or twelfth of an inch, is a meaſure which I ſhall often have occaſion to uſe.

to

to the brain, ſo as to occaſion very imminent danger; outwards towards the integuments, ſo as to warn us that there is diſeaſe. The general thickneſs of the ſkull, and the natural order of two tables, and an intermediate diploe, is very regular, in all the upper parts of the head. In perforating with the trepan, we firſt cut with more labour, through the external table; when we arrive at the cancelli, there is leſs reſiſtance, the inſtrument moves with eaſe, there is a change of ſound, and blood comes from the tearing of theſe veſſels, which run in the cancelli, betwixt the tables of the ſkull. Surgeons thought themſelves ſo well aſſured of theſe marks, that, it became a rule to cut freely and quickly through the outer table, to expect the change of ſound, and the flow of blood, as marks of having reached the cancelli, and then to cut more deliberately and ſlowly through the inner table of the ſkull. But this ſhows an indiſcreet hurry, and unpardonable raſhneſs in operation. The patient, during this ſawing of the ſkull, is ſuffering neither danger nor pain *: and many additional reaſons leads us to refuſe altogether, this rule of practice: for the ſkull of a child conſiſts properly of one table only; or tables are not yet diſtinguiſhed, nor the cancelli formed: in youth, the ſkull has its proper arrangement of cancelli and tables; but ſtill, with ſuch irregularities, and exceptions, as make a hurried operation unſafe: in old age, the ſkull declines towards its original condition, the cancelli are obliterated, the tables approach each other, or are cloſed and condenſed into one; the ſkull become, irregularly thick at ſome points, and at others thin, or almoſt tranſparent; ſo that there can hardly be named any period of life, in which this operation may be performed quickly, and ſafely at once. But, beſides this gradual progreſs of a bone increaſing in thickneſs and regularity, as life advances, and growing irregular and thinner in the decline of life, we find dan-

* There is a ſtate of inflammation, either under the dead bone or in the ſurrounding bone which gives extreme pain, even when the ſilver probe touches the dead bone. C. B.

gerous

gerous irregularities, even in younger ſkulls. There are often at uncertain diſtances, upon the internal ſurface of the ſkull, hollows and defects of the internal table, deep pits, or foveæ, as they are called, produced perhaps by the impreſſions of contorted veins. Theſe foveæ increaſe in ſize and in number, as we decline in life: they are more frequent on the inner ſurfaces of the parietal and frontal bones; ſo that in thoſe places where the ſkull ſhould be moſt regular, we are never ſure, and muſt, even in the ſafeſt places, perforate gradually and ſlowly.

The BONES of the ſkull are divided into thoſe of the cranium; the bones of the face; and common, or intermediate bones.

The bones of which the cranium, or ſkull-cap is formed, are eight in number. 1. The FRONTAL-BONE, or bone of the forehead, forms the upper and fore part of the head,—extends a little towards the temples, and forms alſo the upper part of the ſocket for the eye. 2. The PARIETAL BONES, are the two large and flat bones which form all the ſides, and upper part of the head; and are named parietalia, as they are the walls or ſides of the cranium. 3. The OS OCCIPITIS, is named from its forming all the occiput or back of the head, though much of this bone lies in the neck, and is hidden in the baſis of the ſkull. 4. The OSSA TEMPORUM form the lower parts of the ſides of the cranium: they are called temporal, from the hair that covers them being the firſt to turn grey, marking the time of life. 5. The OS ÆTHMOIDES, and, 6. the OS SPHENOIDES, are quite hidden in the baſis of the ſkull: they are very irregular and very difficultly deſcribed, or explained. The OS ÆTHMOIDES, is a ſmall ſquare bone, hollow, and with many cells in it: it hangs over the noſe, and conſtitutes a great and important part of that organ, and at the ſame time ſupports the brain. The olfactory nerves, by paſſing through it at many points, perforate it like a ſieve; and it takes its name from this perforated, or æthmoid plate. The OS SPHENOIDES, is larger and more irregular ſtill; placed fur-

ther back; locked in betwixt the occipital and æthmoidal bones; lies over the top of the throat, ſo that its proceſſes form the back of the noſtrils, and roof of the mouth; and it is ſo placed, as to ſupport the very centre of the brain, and tranſmit almoſt all its nerves.

SUTURES.—All theſe bones are joined together by ſeams, which, from their indented, or dove-tailed appearance, are named ſutures.

1. The CORONAL SUTURE, is that which joins the frontal to the parietal bones; extends almoſt directly acroſs the head, from ear to ear; deſcends behind the eye, into the deep part of the temple; and there loſing its ſerrated appearance, becomes like the ſquamous or ſcaly ſuture, which joins the temporal bones. It is named coronal, becauſe the ancients wore their garlands, on this part of the head. But the ſuture had been better entitled to this name, had it ſurrounded the head, than as it croſſes it.

2. The LAMBDOIDAL SUTURE, is that one which joins the parietals, to the occipital bone. It begins behind one ear, aſcends and arches over the occiput, and deſcends behind the other ear. It thus ſtrides over the occiput, in a form ſomewhat reſembling the letter lambda (Λ), of the Greeks, whence its name.

3. The SAGITTAL SUTURE, joins the parietal bones to each other; runs on the very top of the head; extends forwards from the lambdoid ſuture, till it touches, or ſometimes paſſes the coronal ſuture; and from lying betwixt theſe two ſutures, like an arrow betwixt the ſtring and the bow, it has been named ſagittal.

4. The TEMPORAL SUTURES, join the temporal bones to the parietal, occipital, and frontal bones; the ſphenoid bone alſo enters into the temporal ſuture, juſt behind the eye. The temporal ſuture makes an arch correſponding almoſt with the arch of the external ear; it meets the coronal ſuture, an inch before the ear, and the lambdoidal an inch behind it. This back part belongs as much to the occipital, as to the temporal bone; and ſo has been named ſometimes, additamentum ſuturæ lambdoidalis; ſometimes additamentum ſu-

turæ

turæ ſquamoſæ : for this temporal ſuture is, on account of the edge of the temporal and occipital bones being thin, and like ſcales of armour laid over each other, often named the ſquamous, or ſcaly ſuture.

5. The SPHENOIDAL and ÆTHMOIDAL SUTURES, are thoſe which ſurround the many irregular proceſſes of theſe two bones, and join them to each other, and to the reſt.

6. The TRANSVERSE SUTURE, is one which, running acroſs the face, and ſinking down into the orbits, joins the bones of the ſkull, to the bones of the face; but with ſo many irregularities and interruptions, that the ſtudent will hardly recognize this as a ſuture.

7. The ZYGOMATIC SUTURE, is one which joins a branch of the temporal bone, to a proceſs of the cheek bone; forming an arch, zygoma, or yoke; but this ſuture has no extent, it is a ſerrated appearance at one ſingle point only.

To mark and know theſe ſutures, and to be able to trace them in imagination, upon the naked head, to foreſee where a ſuture will preſent, and how far it runs, may be a matter of great importance to the ſurgeon. Hippocrates, who has had more to praiſe his honeſty than to follow his example, acknowledges his having miſtaken a ſuture for a fracture of the ſkull; and ſince this warning, various contrivances and marks have been thought of, for preventing the like miſtake. It may be uſeful to remember that the ſuture has its ſerræ or indentations, is firmly covered by the pericranium, is cloſe, and does not bleed: but that a fiſſure, or fracture of the ſkull, runs in one direct line, is larger and broader at the place of the injury, and grows ſmaller, as you recede from that, till it vaniſhes by its ſmallneſs; and that it always bleeds. Indeed the older ſurgeons, obſerving this, poured ink upon the ſuſpected part, which, if the ſkull was hurt, ſunk into the fiſſure, and made it black and viſible; but left the ſuture untouched. They alſo directed to make the patient take a wire betwixt his teeth, which being ſtruck like the ſpring of

an inſtrument, he would feel the twang produce a painful and particular ſenſation in the fractured part of the head. But after all theſe obſervations, in place of any true and certain marks, we find a number of accidents which may lead us into a miſtake.

Sutures cannot be diſtinguiſhed by their ſerræ or teeth, for the temporal ſutures want this common character, and rather reſemble capillary fractures of the ſkull *; nor even by their places, for we know that there are often inſulated bones (oſſa wormiana) ſurrounded with peculiar joinings, which ſo derange the courſe of the common ſutures, that the joinings may be miſtaken for fractures of the ſkull, and the oſſa wormiana for broken parts. Sometimes the ſquamous ſuture is double, with a large arch of bone intercepted betwixt the true and the falſe ſuture; or the ſagittal ſuture, deſcending beyond its uſual extent, and quite to the noſe, has been miſtaken for a fracture, and trepanned; and oftener in older ſkulls, the ſutures are entirely obliterated, all over the head. If the ſurgeon ſhould pour ink upon the ſkull, he would have reaſon to be aſhamed of an experiment ſo awkward and unſucceſsful; and for the old contrivance of a wire or cord held in the mouth, it cannot be done, ſince the patient is commonly inſenſible; and even, though leſs hurt, his feelings, after ſuch an accident, muſt be very confuſed; he muſt be too liable to be deceived: and we cannot on ſuch ſlender evidence as this, perform ſo cruel an operation as cutting up the ſcalp, or ſo dangerous a one as the trepan.

For various reaſons, we are careful to trace the bones from their original ſoft and griſtly ſtate, to their perfect condition of hard bone: and moſt of all, we are concerned to do ſo in the head, where, in childhood, the appearances are not ſingular and curious only, but have always been ſuppoſed to indicate ſome wiſe and uſeful purpoſe. It is in this original condition of the ſoft and growing bones, that anatomiſts have ſought to find a theory of the ſutures, how they are formed, and for

* Viz. Fractures as ſmall as a hair, thence named capillary.

what uſes. It has been remarked, that the number of pieces in the ſkull, is infinitely greater in the child than in the man. Theſe bones, oſſifying from their centre towards their circumference, it happens, of courſe, that the fibres are cloſe at the centre of oſſification, and are more ſcattered at the extremities of the bone: when theſe ſcattered fibres of oppoſite bones meet, the growing fibres of one bone ſhoot into the interſtices of that which is oppoſed: the fibres ſtill puſh onwards, till they are ſtopped at laſt, and the perfect future, or ſerrated line of union is formed.

In dilating this propoſition, we ſhould obſerve, that in the boy all the bones in the head are membranous and imperfect. The membranous interſtices begin to be obliterated; the futures are beginning to cloſe; the diſtinction of two tables is not yet eſtabliſhed; the cancelli are not yet interpoſed between the plates, the ſinuſes, or caverns of the bones, as in the forehead, the noſe, and the jaw, are not formed; and each bone is not only incomplete towards its edges and futures, but conſiſts often of many parts. The OS FRONTIS is formed of two pieces, which meet by a membranous union in the middle of the bone. The OSSA PARIETALIA have one great and prominent point of oſſification in the very centre of each, from which diverging rays of oſſification extend towards the edges of the bone. The OS OCCIPITIS is formed in four diſtinct pieces; and the TEMPORAL BONES are ſo fairly divided into two, that their parts retain in the adult the diſtinct names of petrous and ſquamous bones. Although theſe are all the regular points of oſſification yet ſometimes there occur ſmall and diſtinct points, which form irregular bones, uncertain in number or ſize, found chiefly in the lambdoid future, ſometimes numerous and ſmall, more commonly they are few in number, and ſometimes of the full ſize of a crown, always diſtorting more or leſs the courſe of the future, and being thus a ſubject of caution to the ſurgeon: theſe are named OSSA TRIQUETRA, or, TRIANGULARIA, from their angular ſhape, or, WORMIANA, from Olaus

Olaus Wormius, who remarked them firſt. Now the os frontis being formed into two larger pieces, their edges meet early in life, and they form a ſuture; but the bones continuing to grow, their oppoſite points force deeper and deeper into each other, till at laſt the ſuture is entirely obliterated, and the bones unite; and ſo this ſuture is found always in the child, ſeldom in the adult, almoſt never in old age. The occipital bone having four points, they are cloſer upon each other, they meet early, are ſoon united; and, although very diſtinct in the child, no middle ſuture has ever been found in the adult, but always the four pieces are united into one firm and perfect bone. The parietal bones have their rays moſt of all ſcattered; the rays of oſſification run out to a great diſtance, and diverge from one ſingle point, ſo that at their edges they are extremely looſe, and they never fail to form ſutures, by admitting into their interſtices the points and edges of the adjoining bones. The ſureſt and moſt conſtant ſutures are thoſe formed by the edges of the parietal bones; the ſagittal in the middle, the coronal over the forehead, the lambdoidal behind, and the ſquamous ſuture, formed by their lower edges. But another phenomenon reſults at the ſame time, from this meeting and oppoſition of the fibres and interſtices of the growing bones: that when the oppoſite fibres meet too early, they are not fairly admitted into the open ſpaces of the oppoſite bone; but the fibres of each bone being directly oppoſed point to point, they both turn inwards, and form a ridge or ſpine, ſuch as is ſeen on the inner ſurfaces of the frontal and occipital bones. Such is the common theory, which I ſuſpect is imperfect, and which ſhould be received with ſome reſerve, for all the phenomena are not yet explained; we find each ſuture always in its appointed place; we find nothing like a ſuture formed betwixt the head and body of a long bone, though they are formed in diſtinct points, and are not united till after the years of manhood; we find no ſutures when bones are broken and reunited, when they have been ſpoiled, and are replaced, when a piece of ſpoiled bone has been

been cut away, nor when a new ſhaft of a bone is formed by the ſecreting veſſels, and is united to the heads of the old bone. Theſe are accidents which hold us at leaſt in doubt.

It has been ſuppoſed, and, with much appearance of truth, that the ſutures limit the extent of fractures, leave a free communication of the internal with the external parts; that they muſt ſerve as drains from the brain; that they are even capable of opening at times, ſo as to give relief and eaſe in the moſt dreadful diſeaſes of the head. But I fear we are not yet able to ſee the meaning of this peculiarity of ſtructure; for the ſutures are regular and uniform to a wonderful degree, while theſe uſes of them are far from being proved.

The ſutures ſurely were not intended by nature for limiting the extent of fractures: for fractures traverſe the ſkull in all directions; croſs the ſutures with eaſe; and very often, paſſing all the ſutures, they deſcend quite to the baſis of the ſkull, where we dare not follow them with the knife, nor apply the trepan. Indeed we do not even know that limiting the extent of fractures could be a gracious proviſion of nature, ſince it would rather appear by the common accidents, that the more eaſily the bone yields, the leſs is the injury to the brain; and that where the fracture is wide and large, the ſymptoms are milder, and the danger leſs.

Neither were they intended as drains; for ſurely it is a bold poſition to aſſume, that nature has carefully provided for our making iſſues upon the ſutures. When the original openneſs of the head and the membranous condition of the ſutures was firſt obſerved, it was thought to be an obſervation of no ſmall importance. The ancients believed that the membranes of the brain came out by the ſutures, to form the pericranium, and going from that over the ſeveral joints, formed the perioſteum for all the bones. They ſaw a cloſe connection betwixt the external and internal membranes of the ſkull, and they thought that nature had intended there a freer communication, and an occaſional drain. They found the ſutures particularly wide and membranous in a

 child,

child, which they attributed to the watery ſtate of its brain, requiring a freer outlet than in the adult; and accordingly they named the opening of the child's head the bregma, fons, fontanelle, the fountain, by which they believed there was a continual exudation of moiſture from the brain.

We might have expected theſe notions to have vaniſhed with the doctrines of humours and revulſion which gave riſe to them, but both the doctrines, and the practice, have been revived of late years; and a ſurgeon of ſome eminence has been at pains to examine various ſkulls, trying to find which of all the ſutures remains longeſt open, and which ſhould form the readieſt and ſureſt drain; and after a curious examination of each, he decidedly condemns the fontanelle; finds the additamentum of the ſquamous ſuture always open, and expects this ſuperior advantage from placing his iſſues there, that he will command at once a drain both from the cerebellum and from the brain. But theſe notions of derivation and revulſion, of ſerous humours falling upon the brain, of drains of pituita by the noſe, and through the ſutures, were much cheriſhed by the ancients, had been long forgotten, and have not been effectually revived by this attempt.

It cannot be denied, that, in ſome inſtances, the ſutures have continued quite open in thoſe grown in years, or have opened after a moſt wonderful manner, in ſome diſeaſes of the head.

A young man having been brought into an hoſpital ill of a fever, the phyſicians obſerved with ſurpriſe a very ſtrong pulſation behind the ear: upon applying the finger, a ſtrong beating was felt; the part was ſoft and yielding; and upon opening his head, after death, there was found a large membranous ſpace. Diemorbrock found the fontanelle open in a woman of forty years of age. Bauhin ſays, that in his own wife, twenty-ſix years of age, the ſutures were not yet cloſed.

This fontanelle, or opening at the meeting of the coronal and ſagittal ſutures, was once thought to be a ſure

mark

mark for the accoucheur to judge by, both of the life of the child, and of the direction in which its head presents. It is large and soft in a child, and the good women lay a piece of firm cloth upon it, and defend it with particular care. It begins to contract from the time of birth; and in the second and third year, it is entirely closed. Its closing is delayed by weakness, scrophulous complaints, and indeed by any lingering disease; it closes very late in rickets, and in hydrocephalic children the bones never close, but continue soft, yield to the watery swelling of the brain, and separate in a wonderful degree, so as to hold ten or twelve pounds.

As the sutures continue open in a hydrocephalic child, they are said to open again in the few instances where adults are seized with the same disease. We are told that it opens in those dreadful head-aches which are sometimes fatal, and that the celebrated Paschal having died after terrible torments, was found to have the sutures opened again: it is even said that they open during disease, and close after the cure. "That a man of forty "years of age being in the dog-days seized with a raging "fever, delirium, watching, and dreadful pains of the "head, his sutures opened on the seventh day, were "as wide as in a child, not only so as to be distinguished "by the finger, but that the attendants could see the "pulsations of the brain; the fever, after some time, "abated; the pains ceased; the sutures closed, and this "man lived many years in perfect health." So Hildanus reports the case, and he also says, in another instance, that the sutures had parted in a violent hemicrania, with an audible noise.

Yet, if this were a regular design of nature, the relief should be perfect; perhaps the opening of the sutures should be more easy, and the accident almost as common as diseases of the head; or perhaps it had been the more merciful order, to have determined a quick and sudden period for such dreadful and incurable diseases as these.

The sutures of the cranium are accidental merely, and of little use. The result, perhaps, of this well known

known law, that nature ſeeks to facilitate oſſification, by beginning the proceſs in many points; and ſhe eſtabliſhes as many diſtinct points, in healing a broken limb as in forming the ſkull. But however they may be formed, their uſes cannot be of that importance which has been ſuppoſed; for there are twenty ſeparate bones, and twenty ſutures in the face, where they can neither ſtop fractures, nor ſerve as drains, nor open ſo as to give relief.

But if the ſutures of the cranium have any thing peculiar and different from thoſe of the face, in that, perhaps, their peculiar uſes may be found. We cannot paſs unnoticed their looſeneſs and flexibility in the new-born child; how wonderfully the head of the child is increaſed in length, and reduced in breadth in the time of delivery, and how much this conduces to an eaſy and happy labour.

The moſt eminent anatomiſts have condeſcended to remark, that in the various nations of Europe the head has various forms, which they aſcribe to ſo ſlight a preſſure as that which dreſs, or even the poſture of the head might produce. But how very far Veſalius was deceived in calculating thus, is eaſily proved. The Turks, ſays he, have their heads flattened by wearing the turban. But the turban is an eaſtern dreſs: the Turks or Tartars are a northern people, who aſſume this dreſs only when conqueſt brings them into a warmer climate, and the prominent cheek-bones, parted eyes, and flat heads, continue in the Tartars, who have but newly aſſumed the turban, while the conquered nations which have worn it long, are diſtinguiſhed by their regular and beautiful features. Perhaps by contrivance and force, we may diſtort the head of a child; and we may almoſt believe what is told of the negroes of the Caribbee iſlands, who had contrived, by preſſure, to flatten their children's heads, that their race might be in future diſtinguiſhed from thoſe who had ſubmitted to the Spaniſh yoke; or of what is told ſo often of eaſtern nations, that they ſometimes mould the heads of children into monſtrous and uncouth forms, to extort

charity,

charity, or as an act of religion. Were I to aſſign a reaſon for the flexible bones, and wide ſutures, and the yielding condition of the head of the child, I ſhould ſay that it were meant by nature to ſtand in the place of that ſeparation of the bones of the pelvis which has been ſuppoſed, but which cannot exiſt; for the child's head is moulded with little injury, is evolved again without help; and it ſeems a proviſion of nature, ſince the child ſcarcely feels the change: but no woman has been known to have the joinings of the pelvis relaxed or diſſolved without pain and danger, confinement for many months, a temporary lameneſs, and ſometimes ſhe is rendered unable for life.

CHAP. III.

DESCRIPTION OF THE INDIVIDUAL BONES OF THE SKULL.

OS FRONTIS. This bone is compared with a clam-ſhell. It is of a ſemicircular ſhape, hollowed like a ſhell. It is marked on the inſide by a ſpine, or prominent line, which divides the hollow of the bone into two equal parts, and gives riſe to a membranous partition, which divides and ſupports the hemiſpheres of the brain. It is marked on its external ſurface by thoſe high ridges on which the eye-brows are placed, and by two prominences, which are hollow caverns, named the SINUS (or cavities) of the frontal bone. Its orbitary plates are the two thin and delicate lamellæ that depart from the general direction of the bone, and ſtand out horizontally, ſo as to form a part of the ſocket for the eye, or, as it were, a roof defending the upper part of the eye, and a floor for ſupporting the lower part of the brain; and theſe two orbitary plates leave an open ſpace, in which is incaſed the chief part of the æthmoid bone, viz. anciſſura æthmoidea.

The firſt point to be remarked, is the SUPERCILIARY RIDGE, on which the eye-brows are placed: it is a prominent

minent arched line, correfponding in fize and length with the eye-brow which it fupports: over this line the integuments are loofe; here many arteries perforate the bone, which are properly the nutritious arteries of this part of the bone; and we find all over the fuperciliary ridge many fmall holes through which thefe arteries had paffed. Among thefe, there is one hole which is larger and which is diftinguifhed from the reft; for its ufe is not like the others, to tranfmit arteries to the bone, but to give paffage to the frontal nerve and a fmall artery which comes out from the orbit, to mount over the forehead. Sometimes the nerve turns freely over the border of the orbit, and makes no mark, or but a flight one: often lying clofer upon the bone, it forms a notch; but moft commonly, in place of turning fairly over the edge of the orbit, it paffes obliquely through the fuperciliary ridge, and by perforating the bone, makes a hole: this hole is named the SUPERCILIARY HOLE. The artery which comes from the eye to go out upon the forehead is named, where it paffes, the fuperciliary artery, and higher up upon the forehead, the frontal artery: it eftablifhes a communication betwixt the internal arteries of the eye, and external arteries of the forehead and temple. We are always warned of the danger of wounding arteries where they pafs through bones; and ftrange ftories are told of the terrible bleedings which have rifen from this artery, wounded near its hole, and of the convulfions, palfies, and lofs of fight, which have arifen from the accidents, wounds, or lacerations of this frontal nerve; ftories delivered on fuch authorities as we dare not refufe, and yet cannot eafily believe.

The fecond foramen is the FORAMEN ORBITALE INTERNUM, which tranfmits a branch of the ophthalmic divifion of the fifth nerve into the cranium, and finally into the nofe. There are fometimes two foramina in the orbital plate.

The orbitary, or fuperciliary ridge, ends by two proceffes, which, forming the angles of the eye, are named the ANGULAR PROCESSES. The frontal bone has

there-

therefore four angular proceſſes: 1. The two internal angular proceſſes, forming the internal angles of the eyes; and, 2. The two external angular proceſſes which form the external angles of each eye.

Betwixt the two internal angular proceſſes there is the NASAL POINT OR PROCESS. This naſal proceſs is a ſmall ſharp projecting point, which is exactly in the middle of the bone, occupying that ſpace which is exactly in the middle of the bone, which is betwixt the two internal angular proceſſes. It is very irregular and rough all round its root, for ſupporting the two ſmall naſal bones; and this gives them a firm ſeat, and ſuch a hold upon the root of the forehead that they oftener are broken than diſplaced.

From the external angular proceſs there extends backwards and upwards the temporal ridge or ſpine.

At the inner end of the ſuperciliary ridge, is that bump which marks the place of the frontal ſinus, which alſo indicates their ſize; for where this riſing is not found, the ſinuſes are awanting, or are very ſmall; but this is no ſure, nor abſolute mark of the preſence of theſe ſinuſes, which often, in the flatteſt foreheads, are not entirely awanting.

The ſinuſes * of the os frontis are two in number, one on either ſide above the root of the noſe: they are formed by a receding of the two tables of the ſkull from each other: they are formed at firſt with the common cancelli, and at firſt they reſemble the common cancelli, as if they were only larger cells: gradually they enlarge into two diſtinct cavities, often of very conſiderable ſize, going backwards into the orbitary plate, or ſideways into the orbitary ridge, or upwards through one half of the frontal bone; and Ruiſch had, in a gianteſs (puella

* The word ſinus is uſed in two ſenſes: we call the cavities or cells, within the ſubſtance of a bone, the ſinuſes of that bone; as the ſinuſes of the forehead, of the ſphenoid, æthmoid or maxillary bones: we call alſo certain great veins by the ſame name of ſinuſes; thus the great veins being enlarged where they approach the heart, and the veins being particularly large in the brain and the womb, we call them them the ſinuſes of the heart, of the brain, and of the womb.

gigantica),

gigantica), ſeen them paſs the coronal ſuture, and extend ſome way into the parietal bones.

The two ſinuſes of either ſide are divided by a partition; but ſtill they communicate by a ſmall hole: ſometimes the partition is almoſt awanting, and there are only croſſings of the common lamellated ſubſtance; and though the commmunication with one another is not always found, they never fail to communicate with the noſe: this indeed ſeems to be their chief uſe; for the frontal ſinuſes are the beginning of a great train of cells, which, commencing thus in the frontal bone, extend through the æthmoidal, ſphenoidal and maxillary bones, ſo as to form an organ of great extent and uſe belonging to the noſe; but perhaps not ſo much for extending the organ of ſmelling, as for making a more ſonorous voice: for we have no proof that the ſinuſes are part of the organ of ſmell; unleſs we ſhould accept of this as a proof, that, by ſmelling of ſtrong volatiles, pain ſhoots upwards into the forehead; though by the ſame rule, the eyes ſhould be alſo a part of the ſame organ, ſince they are pained, and tears begin to flow: but we do know that they belong to the voice, and raiſe its tone, for we feel the trembling note reſound through all theſe cells, ſo that the voice is ſonorous while they are free; is damped when the ſinuſes are oppreſſed by their membranes being thickened by cold; or is almoſt ſuppreſſed when the ſinuſes are entirely cloſed; or when, by venereal ulcers, the curtain of the palate is conſumed, no part of the voice paſſing upwards into the noſe, it is almoſt loſt.

This has given riſe to a very common miſtake: that as theſe ſinuſes are awanting in the child whoſe forehead is flat, as they enlarge gradually, and are fully formed about the fifteenth year, the vox rauca, the breaking of the voice, which is obſerved about that time, muſt be owing to the evolution of theſe cells: but the female voice does not undergo the ſame change by the evolution of theſe cells; and caſtration, which ſurely can have no effect on theſe cavities, keeps down the eunuch's to the treble key

key of the female voice *. The miſtake lies in ſuppoſing theſe cavities to raiſe the tone or note in which we ſpeak, while they only add clearneſs and ſtrength. The membrane which lines theſe cavities is thin, exquiſitely ſenſible, and is a continuation of the common membrane of the throat and noſe. A thin humour is poured out upon its ſurface to moiſten it and keep it right. This the ancients did not conſider as a mere lubricating fluid, but as a purgation of the brain, drawn from the pituitary gland, which could not be diminiſhed without danger, and which it was often of conſequence to promote.

They are ſubject to one accident chiefly, viz. inſects, which neſtle there, and produce inconceivable diſtreſs; and it is particular, that they more frequently lodge in the frontal ſinuſes, that in the cavities of any of the other bones. In ſheep and dogs ſuch inſects are very frequent, as in ſeeking their food, they carry their noſe upon the ground; and it has been proved, or almoſt proved, that in man they ariſe from a like cauſe. Indeed, what can we ſuppoſe, but that they get there by chance; thus, a man having ſlept in barns, was afflicted with dreadful diſorders in the forehead, which were relieved upon diſcharging from the noſe, a worm of that kind which is peculiar to ſpoiling corn; while others have had the complaint, by ſleeping upon the graſs. But there is ſomething very particular in this, that far the greater number of theſe worms have been of the centipede kind; generally long, an inch in length, with one hundred, or, according to Linnæus, one hundred and twelve feet, and not unfrequently covered with hair. There are reports which ſeem to prove, that ſome have died of this complaint, and in a very miſerable way. In many caſes it has been attended with delirium; and in almoſt every inſtance it has continued for years. No wonder, then, that the

* I have ſeen a boy, of four years of age, whoſe parts of generation were prematurely developed with buſhy hair upon the pubes. This man-child had the rough broken voice, though the bones of the forehead were flat. C. B.

trepanning

trepanning of these sinuses has often been proposed; but I have never read of a well marked case, so that we could be assured before hand, of finding worms: they have, in most cases, been discovered rather by chance. The patient might be relieved on easier terms, by the injection of aloes, assafœtida, myrrh, the use of snuff or smoaking, and pressing the fumes upwards into the nose. Much should be tried, before undertaking a dangerous operation on such slender proofs.

It may be right, in cases of fractures, to decline applying the trepan above the sinuses, unless a fracture cannot be raised in any easier way; and we must be especially careful, to distinguish a fracture of the outer table only, from entire fractures of this bone. For Palfin says, that the outer table being broken, and the natural mucus of the sinus being corrupted and flowing out, has been mistaken for the substance of the brain itself. And Parèe, who first gives this caution, affirms, "that he had seen surgeons guilty of this mis- "take, applying the trepan, and so killing their un- "happy patients *."

The SPINE OF RIDGE which runs upon the internal surface of the frontal bone, is to be observed, as it gives a firm hold to the falx, or that perpendicular membrane, which, running in the middle of the head, divides and supports the brain. This is more or less prominent in different skulls, and according to the age. The spine is more prominent at its root; but as it advances up the forehead, it decreases, and often ends in a groove. The spine gives firm hold for the falx, and the groove lodges the great longitudinal sinus, or in other words, the great vein of the brain, which runs along the head, in the course of the perpendicular partition, or falx. At the root of this spine, there is a small blind hole; it is named blind, because it does not pass quite through the bone, and the beginning of the falx, dipping down into this hole, gets a firmer hold.

* For a more perfect account of the pathology of the sinuses, see the Surgery, 4to. vol. ii.

The ancients, thinking that the hole defcended through both tables into the nofe, believed, that the dangerous and ungovernable bleedings at the nofe muft be through this hole, and from the fore end, or beginning of the longitudinal finus.

The ORBITARY PROCESS is the laft remarkable point of the frontal bone. The orbitary proceffes are two thin plates, departing from the general direction of the bone, and ftanding inwards at right angles: they cover the eye, and fupport the brain. By the continual rolling of the eye, and the preffure of the brain, they are extremely thin and tranfparent; the rolling of the eye makes them exquifitely fmooth below, and on their upper furfaces, they are impreffed with the frequent convolutions of the brain; fo that a wound through the eye, endangers more than the eye; for it paffes eafily forward into the brain, and is inftantly fatal; it is the aim of the fencer, and we have known in this country, a young man killed by the pufh of a foil, which had loft its guard.

Upon the orbitary plate, and juft under the fuperciliary ridge, there are two depreffions in the focket of each eye: the one is very fmall, and deeper at the inner corner of the eye, under the orbitary hole, which is the mark of the fmall cartilaginous pully, in which the tendon of one of the mufcles of the eye plays; the other a more gentle and diffufed hollow, lies under the external angular procefs, is not deep, but is wide enough to receive the point of a finger, and is the place where the lachrymal gland lies, that gland which fecretes the tears, and keeps the eye moift.

PARIETAL BONE. — The parietal bones form much the greater fhare of the cranium: they are more expofed than any others, are the moft frequently broken, and the moft eafily trepanned; for the parietal bones, are more uniform in their thicknefs, and more regular in their two tables and diploe, than any others.

 But

But the accidental varieties of pits and depreſſion, are very frequent in them and the ſinus or great vein, and the artery which belongs to the membranes of the brain, both make their chief impreſſions upon this bone.

The ſquare form of the bone produces four angles; and in ſurgery, we ſpeak of the frontal, the occipital, the maſtoidean, and temporal angles, of the parietal bone. It has deeply ſerrated edges, which unite them with each other, and with the occipital and frontal bones. All the corners of this bone are obtuſe, except that one which lies in the temple, and which, running out to a greater length than the other corners, is ſometimes named the SPINOUS PROCESS of the parietal bone, though there can be no true proceſs in a bone ſo regular and flat. The lower edge of the bone is a neat ſemi-circle, which joins the parietal to the temporal bone; and the edge of each, is ſo flaunted off, that the edge of the temporal overlaps the edge of the parietal, with a thin ſcale, forming the ſquamous ſuture. About an inch above the ſquamous ſuture, there is a ſemi-circular ridge, where the bone is particularly white and hard; and rays extend downwards from this, converging towards the jugum. The white ſemi-circular line repreſents the origin of the temporal muſcle; and the converging lines expreſs the manner in which the fibres of the muſcle are gathered into a ſmaller compaſs, to paſs under the jugum, or arch of the temple. The ſagittal ſuture, or meeting of the two parietals, is marked with a groove as big as the finger, which holds the longitudinal ſinus, or great vein of the brain; but the groove is not ſo diſtinctly ſeen, unleſs the two bones are put together; for one half of this flat groove belongs to each bone.

The great artery of the dura mater touches the bone at that angle of it which lies in the temple. It traverſes the bone from corner to corner, ſpreading from the firſt point, like the branches of a tree: it beats deep into the bone where it firſt touches it; but where

it

it expands into branches, its impreſſions are very ſlight, commonly it makes a groove only, but ſometimes it is entirely buried in the bone ; ſo that at the lower corner of the parietal, we cannot eſcape cutting this veſſel, if we are forced to operate with the trepan.

There is but one hole in the parietal bone : it is ſmall and round, is within one inch of the meeting of the lambdoidal and ſagittal ſutures, and gives paſſage to a ſmall external vein, which goes inwards to the ſinus, and to a ſmall artery which goes alſo inwards to the dura mater, or rather to the falx.

The meeting of the frontal and parietal bones, being imperfect in the child, leaves that membranous inteſtice, which by ſome, is named folium or folliolum, from its reſembling a trefoil leaf, and was named by the ancients hypothetically, bregma, fons *, or fountain ; they thinking it a drain of moiſture from the brain ; and ſo the parietal bones are named oſſa bregmatis.

OS OCCIPITIS, has alſo the names of os memoriæ, and os nervoſum. It is the thickeſt of the cranial bones, but is the leaſt regular in its thickneſs, being tranſparent in ſome places, and in others ſwelling into ridges of very firm bone. It gives origin or inſertion to many of the great muſcles, which move the head and neck ; it ſupports the back part of the brain, contains the cerebellum or leſſer brain, tranſmits the ſpinal marrow, and and is marked with the conflux of the chief ſinuſes, or great veins of the brain.

The EXTERNAL SURFACE is exceedingly irregular, by the impreſſions of the great muſcles of the neck : Betwixt the inſertions of the muſcles, projecting lines are on the bone. In the middle of the bone, and betwixt the muſcles of oppoſite ſides, there runs a ridge from above downward ; at the upper margin of the

* The word pulſatilis, or fons pulſatilis, or beating fountain, was added, becauſe we feel the beating of the arteries of the brain there.

 inſertion

insertion of the trapezius, there is formed a superior transverse spine or ridge, and in the same way, directly above the insertion of the recti, there is an inferior transverse spine. In a strong man, advanced in years, where the ridges and hollows are strongly marked, the point where the superior transverse crosses the perpendicular one, it is so very prominent, as to be named the POSTERIOR TUBEROSITY of the occipital bone.

The INTERNAL SURFACE. Opposite to these ridges there are similar crucial ridges within; but more regular, smooth, and equal, and making only one transverse line. The *tentorium cerebello super-extensum*, is a diaphragm or transverse partition, which crosses the skull at its back part; cuts off from the rest of the cranium the hollow of the occipital bone, appropriates that cavity for the cerebellum, and defends the cerebellum from the weight and pressure of the brain. This tentorium, or transverse membrane, is attached to the GREAT INTERNAL RIDGE of the occipital bone. In the angle where this membrane is fixed to the ridge, lies the great sinus or vein, which is called longitudinal sinus, while it is running along the head; but the same sinus, dividing in the back of the head, into two great branches, changes its name with its direction; and the forkings of the vessel are named the right and left lateral sinuses, which go down through the basis of the skull; and being continued down the neck, are there named the great or internal jugular veins. This forking of the longitudinal, into the lateral sinuses, makes a TRIANGULAR OR TRIPOD-LIKE GROOVE, which follows the internal ridges of the occipital bone: and above and below the transverse ridge there are formed four plain and smooth hollows. The two upper ones, are above the tentorium, and contain the backmost lobes of the brain; the two lower ones are under the tentorium, and hold the lobes of the cerebellum or little brain.

PROCESSES. The processes or projections of the occipital bone are few and simple. 1. There is a part of the bone which runs forward from the place of the foramen

men magnum, lies in the very centre of the baſe of the ſkull, joins the occipital to the ſphenoidal bone, and which, both on account of its place, (wedged in the baſis of the ſkull), and of its ſhape, which is rather ſmall, and ſomewhat of the form of a wedge, is named the CUNIFORM, OR WEDGE-LIKE PROCESS of the occipital bone. And, 2. There are two ſmall oval proceſſes, or button-like projections, which ſtand off from the ſide, or rather from the forepart of the foramen magnum, or great hole, and which, being lodged in joints belonging to the upper bone of the neck, form the hinge on which the head moves. Theſe two proceſſes are named the CONDYLES of the occipital bone. They are not very prominent, but rather flattened; are of an oval form, and have their fore-ends turned a little towards each other; ſo that by this joint the head moves directly backwards or forwards, but cannot turn or roll. The turning motions are performed chiefly by the firſt bones of the neck. Round the root of each condyle, there is a roughneſs, which ſhows where the ligament ties this ſmall joint to the correſponding bone of the neck.

HOLES.—1. Theſe condyles ſtand juſt on the edge of the FORAMEN MAGNUM, or great hole of the head, which tranſmits the ſpinal marrow, or continuation of the brain; and the edges of this hole (which is almoſt a regular circle) are turned and ſmoothed; a little thicker at the lip, and having a roughneſs behind that, giving a firm hold to a ligament, which, departing from this hole, goes down through the whole cavity of the ſpine, forming at once a ſheath for the ſpinal marrow, and a ligament for each individual bone. There paſſes down through this great hole the ſpinal marrow, and the vertibral vein. There comes up through it the vertebral arteries, which are of great importance and ſize; and a ſmall nerve, which, from its coming backwards from the ſpine to aſſiſt certain nerves of the brain, is named the ſpinal acceſſory nerve.

2. The ſecond hole is placed a little behind the ring of the foramen magnum, and, juſt at the root of either

condyle,

condyle, is round, and large, eafily found, and fome times it is double; it tranfmits the ninth pair, or great lingual nerve.

3. There is another hole fmaller, and lefs regular than this laft. It is exactly behind the condyle, while the lingual hole is before it. It is for permitting a fmall vein of the neck to enter and drop its blood into the great lateral finus; but often it is not formed, and this trifling vein gets in by the great occipital hole.

4. We fhall defcribe with the temporal bone that wide hole which is common to the temporal and occipital bones, and which tranfmits the great lateral finus.

TEMPORAL BONE. — The temporal bone is, in the child, two bones; which retain their original names of pars petrofa and pars fquamofa. The whole bone is very irregular in its thicknefs, and hollows, and proceffes. The PARS SQUAMOSA is a thin or fcaly part; rifes like a fhell over the lower part of the parietal bone, and is fmoothed and flattened by the rubbing of the temporal mufcle. The PARS PETROSA, often named OS LAPIDOSUM, or ftony bone, is hard, irregular, rocky; jutts inwards towards the bafis of the fkull; contains the organ of hearing, and, of courfe, receives and tranfmits all the nerves which are connected with the ear. There is a third portion of this bone, viz. the occipital angle, which is thick and hard; is divided into cells, and forms thofe caverns which are fuppofed to be chiefly ufeful in reverberating the found.

The fquamous part is grooved, to make the fquamous future; is fcolloped or fringed; and exceedingly thin on its edge; it is radiated, in confequence of its original offification fhooting out in rays. The petrous part again is triangular, unequal by the cavities of the ear; it has a very hard, fhining, polifhed-like surface; exceeded in hardnefs by nothing but the enamel of the teeth. Where it projects into the bafe, it has feveral open points, which are filled up with cartilaginous or ligamentous fubftance; and its occipital angle is con-

nected with the other bones by the additamentum futuræ fquamofæ.

PROCESSES. 1. The ZYGOMATIC PROCESS rifes broad and flat before the ear; grows gradually fmaller as it ftretches forward to reach the cheek-bone: it forms with it a zygoma, yoke, or arch of the temple, under which the temporal mufcle plays. The temporal mufcle is ftrengthened by a firm covering of tendon, which ftretches from the upper edge of this zygoma to the white line on the parietal bone; and feveral mufcles of the face arife from the lower edge of the zygoma, particularly one named maffeter, which moves the jaw; and one named zygomaticus, or diftortor oris, becaufe it draws the angle of the mouth. The zygomatic procefs is united by a fhort future to the cheek bone.

2. The STYLOID PROCESS, is fo named from a flight refemblance to the ftylus, or point with which the ancients engraved their writings on tables of wax. It is cartilaginous long after birth; even in the adult, it is not completely formed; it is exceedingly delicate and fmall; and when its cartilaginous point is fairly offified, as in old men, it is fometimes two inches long. It ftands obliquely out from the bafis of the head, and is behind the jaws; fo that it gives convenient origin to a ligament which goes downwards to fupport the os hyoides, or bone of the tongue; and it is the origin of many curious mufcles, chiefly of the throat and jaws. One flender mufcle going downwards from the ftyloid procefs, and expanding over the pharynx, is called ftylo-pharyngeus; one going to the os hyoides; is the ftylo-hyoideus; one going to the tongue, is the ftylo-gloffus: and fince the procefs is above and behind thefe parts, the mufcles muft all pull backwards and upwards, raifing according to their infertions, one the pharynx, another the os hyoides, another the tongue.

3. PROCESSUS VAGINALIS will not be eafily found, nor acknowledged as a procefs; for it is only a fmall rifing of a ridge of the bone, with a rough and broken-like edge, on the middle of which the ftyloid procefs ftands; it is, in fhort, the root of the ftyloid procefs which

which anatomifts have chofen to obferve, though it gives origin to no particular part; and which they have named vaginalis, as if it refembled a fheath for the ftyloid procefs.

4. MASTOIDEUS, or MAMMILLARIS, is a conical nipple-like bump, like the point of the thumb; it projects from under the ear, and is eafily felt with the finger without; it is hollow, with many cells which enlarge the tympanum, or middle cavity of the ear, and are thought to reverberate and ftrengthen the found. Under its root, there is a deep and rough rut which gives a firm hold to the firft belly of the digaftric mufcle; and the point or nipple of this procefs is the point into which the maftoid mufcle is inferted from before; and the complexus obliquus and trachelomaftoideus mufcles from behind. It has been propofed of late years, that, in certain cafes of deafnefs, we fhould open this part with the trepan.

5. The AUDITORY PROCESS is juft the outer margin of the hole of the ear. It is in a child a diftinct ring, which is laid upon the reft of the bone. The membrane of the ear is extended upon this ring, like the head of a tambour upon its hoop, whence this is named the circle of the tambour by the French, and by us the drum of the ear. In the adult, this ring is fairly united to the bone, and is named the proceffus auditorius; and may be defined a circle, or ring of bone, with a rough irregular edge; the drum or membrane of the ear is extended upon it, and the cartilaginous tube of the ear is fixed to it; and this ring occupies the fpace from the root of the mamillary to the root of the zygomatic procefs.

HOLES. The temporal bone is perforated with many holes, each of which relates to the organ of hearing; fome for permitting nerves to enter; others to let them out; others for the free paffage of air to the internal ear.

1. The MEATUS AUDITORIUS EXTERNUS (the circle of which has been defcribed), is covered with the membrane of the drum, and communicates the vibratory motion

motion of the air for moving and exciting the internal organs.

2. The MEATUS AUDITORIUS INTERNUS, is that hole by which the auditory nerves have accefs to the ear. It is a very large hole, feated upon the back of the pars petrofa, which is of a triangular form. The hole is at firft large, fmooth, almoft a regular circle, with a fort of round lip. Within this are feen many fmall holes, the meaning of which is this: the auditory nerve is double from its very origin in the brain: it confifts, in fact, of two diftinct nerves, the portio dura, and the portio mollis. The portio mollis is a large foft and delicate nerve, which conftitutes the true organ of hearing; and when it is admitted into the ear, it is expanded into a thin web which fpreads over all the cavities of the ear, as the cochlea, femi-circular canals, &c. The portio dura, the fmaller part of the nerve, paffes indeed through the ear, but it is quite a foreign nerve; it is not diftributed within the ear; it keeps the form of a diftinct cord, and, paffing through the temporal bone, it comes out upon the cheek, where it is expanded; fo that the portio dura is a nerve of the face, paffing through the ear, but forming no part of that organ. Thus the two nerves, the portio dura and mollis, enter together; they fill the greater hole, and then they part: the portio dura, entering by one diftinct hole, takes its courfe along a diftinct canal, the aqueduct of Fallopius, from which it comes out upon the cheek; while the portio mollis, entering by many fmaller holes into the cochlea, femi-circular canals, and other internal parts of the ear, is expanded in thefe cavities to form the proper organ of hearing.

3. There is a fmall hole which will admit the point of a pin upon the fore part of the petrous bone. This hole receives a fmall twig reflected from the fifth pair of nerves: the nerve is as fmall as a fewing thread; it can be traced along the petrous bone by a fmall groove, which conducts it to the hole; and when it enters the ear, it goes into the fame canal with the portio dura, and joins itfelf to it.

4. The

4. The hole by which the portio dura passes out upon the cheek, is found just before the mastoid, and behind the styloid process; and being betwixt the two, it is named the STYLO-MASTOID hole, and is so small, as just to admit a pin.

5. The hole for the Eustachian tube is very irregular. No air can pass through the membrane of the drum; and as air is necessary within the ear, it is conveyed upwards from the palate by the ITER A PALATO AD AUREM, or as it is commonly called, the EUSTACHIAN TUBE. This tube is long, and of a trumpet form; its mouth, by which it opens behind the nostril, is wide enough to receive the point of the finger, it grows gradually smaller as it advances towards the ear: it is cartilaginous in almost its whole length; very little of it consists of firm bone; so that the student, in examining the skull, will hardly find the Eustachian tube; for the cartilage being rotten away, nothing is left but that end of the canal that is next the ear, which open both above and below, ragged, irregular, and broken.

When we have a sore throat, the pain extends up along this tube into the ear; when we have a cold, both our voice and our hearing is hurt; the one by the stuffing of the sinuses, the other by the stuffing of the Eustachian tube. When we shut the nose and mouth, and blow strongly, we feel a crackling in the ear, as in the place of the Eustachian tube; when we dive, we feel the same, by the condensation of the air: and sometimes by forcing the air strongly upwards through the ear, or by vomits, obstruction of the Eustachian tube, and the deafness which attends that accident, are very suddenly, and, we may say, violently removed; or sometimes the cure is attempted by syringing, or by cleaning the mouth of this tube with a probe, just as we do the external ear.

The other holes do not relate to the ear, and are chiefly for transmitting the great blood vessels of the brain.

1. The CAROTID ARTERY, the chief artery of the brain, enters into the skull near the point of the petrous bone,

bone, and just before the root of the styloid process. The artery goes first directly upwards, then obliquely forwards through the bone, and then again upwards, to emerge upon the inside of the skull; so that the carotid makes the form of an Italic *S*, when it is passing through the substance of the bone; and, in place of a mere hole, we find a sort of short canal, wide, a little crooked, and very smooth within. There seems to be a particular design in this angle, which the artery is forced to make: perhaps it is designed to abate the violence with which the blood would drive forwards into the brain; for in many of the lower animals, there are still more particular provisions than this, the artery being prevented from entering the brain in one great trunk, by a curious division, into many branches, which meet again. It is at this particular point that we are sensible in our own body of the beating of these two great arteries; and Haller is at pains to inform us, that, during a fever, he felt this beating in a very distressing degree.

2. The GREAT LATERAL SINUS comes out through the temporal bone, to form the internal jugular vein. The course of the sinus may be easily traced by the groove of the occipital bone downwards, behind the pars petrosa: there also it makes a deep groove, and ends with a large intestine-like turn, which makes a large cavity in the temporal bone, big enough to receive the point of the finger. The sinus passes out, not by any particular hole in the temporal bone, but by what is called a COMMON HOLE, viz. formed one half by the temporal and one half by the occipital bone. This hole is very large; is lacerated or ragged-like. It is sometimes divided into two openings, by a small point, or spine of bone. The larger opening on one side of that point transmits the great sinus, where it begins to form the jugular vein; and the smaller opening transmits the eighth nerve of the skull, or par vagum which goes down towards the stomach, along with the jugular vein.

There is a small furrow upon the very angle or ridge of the petrous bone, which is made by a small vein of the brain going towards the end of the lateral sinus.

3. There

3. There is a ſmall hole on the outſide of this bone, in the occipital angle; or rather the hole is oftener found in the line of the ſuture (the additamentum ſuturæ ſquamoſæ). Sometimes it is in the occipital bone; or ſometimes it is wanting: it tranſmits a trifling vein from without, into the great ſinus, or a ſmall artery going to the dura mater.

That hollow under the root of the zygomatic proceſs, which lodges the hinge of the jaw-bone, muſt be deſcribed along with the lower jaw.

The ÆTHMOID BONE — Is perhaps one of the moſt curious bones of the human body. It appears almoſt a cube, not of ſolid bone, but exceedingly light, ſpongy, and conſiſting of many convoluted plates which form a net-work like honey-comb. It is curiouſly encloſed in the os frontis, betwixt the orbitary proceſſes of that bone. One horizontal plate receives the olfactory nerves, which perforate that plate with ſuch a number of ſmall holes, that it reſembles a ſieve, whence the bone is named cribriform, or æthmoid bone. Other plates dropping perpendicularly from this one, receive the divided nerves, and give them an opportunity of expanding into the organ of ſmelling; and theſe bones, upon which the olfactory nerves are ſpread out, are ſo much convoluted, as to extend the ſurface of this ſenſe very greatly, and are named ſpongy bones. Another flat plate lies in the orbit of the eye, which being very ſmooth, by the rolling of the eye, is named the os planum, or ſmooth bone; ſo that the æthmoid bone ſupports the forepart of the brain, receives the olfactory nerves, forms the organ of ſmelling, and makes a chief part of the orbit of the eye; and the ſpongy bones, and the os planum, are neither of them diſtinct bones, but parts of this æthmoid bone.

The CRIBRIFORM PLATE is exceedingly delicate and thin, lies horizontally over the root of the noſe, and fills up neatly the ſpace betwixt the two orbitary plates of

of the frontal bone. The olfactory nerves, like two ſmall flat lobes, lie out upon this plate, and, adhering to it, ſhoot down like many roots through this bone, ſo as to perforate it with numerous ſmall holes, as if it had been dotted with the point of a pin, or like a nutmeg grater.

This plate is horizontal; but its proceſſes are perpendicular, one above, and three blow.

1. The firſt perpendicular proceſs is what is called CRISTA GALLI, a ſmall perpendicular projection ſomewhat like a cock's comb, but exceedingly ſmall, ſtanding directly upwards from the middle of the cribriform plate, and dividing that plate into two; ſo that one olfactory nerve lies upon each ſide of the criſta galli; and the root of the falx, or ſeptum, betwixt the two hemiſpheres of the brain, begins from this proceſs. The foramen cæcum, or blind hole of the frontal bone, is formed partly by the root of the criſta galli, which is very ſmooth, and ſometimes, it is ſaid, hollow or cellular.

2. Exactly oppoſite to this, and in the ſame direction with it, *(i. e.)* perpendicular to the æthmoid plate, ſtands out the NASAL PLATE of the æthmoid bone. It is ſometimes called the azygous, or ſingle proceſs of the æthmoid, and forms the beginning of that ſeptum or partition which divides the two noſtrils. This proceſs is thin, but firm, and compoſed of ſolid bone; it is commonly inclined a little to one or other ſide, ſo as to make the noſtrils of unequal ſize. The azygous proceſs is united with the vomer, which forms the chief part of the partition; ſo that the ſeptum, or partition of the noſe, conſiſts of this azygous proceſs of the æthmoid bone above, of the vomer below, and of the cartilage in the fore or projecting part of the noſe; but the cartilage rots away, ſo that whatever is ſeen of this ſeptum in the ſkull, muſt be either of the æthmoid bone or the vomer.

3. Upon either ſide of the ſeptum, there hangs down a SPONGY BONE, one hanging in each noſtril. They are each rolled up like a ſcroll of parchment: they

are very ſpongy; are covered with a delicate and ſenſible membrane, and when the olfactory nerves depart from the cribriform plate of the æthmoid bone, they attach themſelves to the ſeptum, and to theſe upper ſpongy bones, and expand upon them ſo, that the convolutions of theſe bones are of material uſe in expanding the organ of ſmelling, and detaining the odorous effluviæ till the impreſſion be perfect. Their convolutions are more numerous in the lower animals, in proportion as they need a more acute ſenſe. They are named ſpongy, or turbinated bones, from their convolutions, reſembling the many folds of a turban.

The ſpongy bones have a great many honey comb-like cells connected with them, which belong alſo to the organ of ſmell, and which are uſeful perhaps by detaining the effluviæ of odorous bodies, and alſo by reverberating the voice. Thus, in a common cold, while the voice is hurt by an affection of theſe cells the ſenſe of ſmelling is almoſt loſt.

4. The ORBITARY PLATE of the æthmoid bone is a large ſurface, conſiſting of a very firm plate of bone, of a regular ſquare form, exceedingly ſmooth and poliſhed: it forms a great part of the ſocket for the eye, lying on its inner ſide. When we ſee it in the detached bone, we know it to be juſt the flat ſide of the æthmoid bone; but while it is incaſed in the ſocket of the eye, we ſhould believe it to be a ſmall ſquare bone; and from this, and from its ſmoothneſs, it has got the diſtinct name of os planum.

5. The os UNGUIS ſhould alſo, perhaps, be counted as a part of this bone; for though the os unguis, when obſerved in the orbit, ſeems to be a ſmall detached bone, thin, like a ſcale, and of the ſize of the finger nail (whence it has its name), yet in the adult the os unguis is firmly attached to the æthmoid bone, comes along with it when we ſeparate the pieces of the ſkull, and when the os unguis is pared off from the æthmoid bone, it expoſes the cells.

This os unguis, then, is a ſmall ſcaly-like plate, in the inner corner of the orbit juſt over the noſe. We find

find in it that groove which holds the lachrymal lac, and condncts it to the nofe; and it is this thin bone that we perforate in making the new paffage into the nofe, when there is an obftruction in the natural duct.

6. The CELLS of the æthmoid bone, which form fo important a fhare of the organ of fmell, are arranged in great numbers, along the fpongy bone. They are fmall neat cells, much like a honeycomb, and regularly arranged in two rows, parted from each other by a thin partition; fo that the os planum feems to have one fet of cells attached to it, while another regular fet of cells belongs in like manner to the fpongy bones. The cells are thus twelve in number *, opening into each other, and into the nofe.

Thefe cells are frequently the feat of venereal ulcers, and the fpongy bones are the furface where polypi often fprout up. And from the general connections and forms of the bone, we can eafily underftand how the venereal ulcer, when deep in the nofe, having got to thefe cells, cannot be cured, but undermines all the face; how the venereal difeafe, having affected the nofe, foons fpreads to the eye, and how even the brain itfelf is not fafe. We fee the danger of a blow upon the nofe, which, by a force upon the feptum, or middle partition, might deprefs the delicate cribriform plate, fo as to opprefs the brain with all the effects of a fractured fkull, and without any operation which could give relief. And we alfo fee much danger in pulling away polypi, which are firmly attached to the upper fpongy bone.

SPHENOIDAL BONE.—The fphenoidal bone completes the cranium, and clofes it below. It is named SPHENOID CUNIFORM, or WEDGE-LIKE bone, from its being incafed in the very bafis of the fkull; or it is named os MULTIFORME, from its irregular fhape. It is united to thirteen diftinct bones. It is much of the fhape of a bat, whence it is often named the PTEREGOID

* The number is commonly twelve, bt t not regularly fo.

BONE,

BONE, its temporal proceſſes being like extended wings; its proper pteregoid proceſſes like feet; its middle like the body and head of a bat; its wing like proceſſes, are in the hollow of the temple, forming a part of the ſquamous future, and alſo compoſing a part of the orbit of the eye. Its pteregoid proceſſes hang over the roof of the mouth, forming the back of the noſtrils: the body is in the very centre of the ſkull, and tranſmits five of the nerves from the brain, beſides a reflected nerve; but ſtill the body bears ſo ſmall a proportion to the bone, that we have not a regular centre to which all the proceſſes can be referred; ſo that we are always in deſcribing this bone, moving forwards from point to point, from one proceſs or hole to the next.

PROCESSES.—1. The ALÆ, or WINGS, often named temporal proceſſes, riſe up in the temple, to form part of the hollow of the temple; and the wings of the ſphenoid bone meeting the frontal, parietal, and temporal bones, by a thin ſcaly edge, they make part of the ſquamous ſuture, and give a ſmooth ſurface for the temporal muſcle to play upon.

The other ſide of this ſame proceſs looks towards the ſocket of the eye, and has a very regular and ſmooth ſurface; it is oppoſite to the os planum. As the æthmoid bone forms part of the inſide of the orbit, the wing of the ſphenoid bone forms part of the outſide of the orbit; and ſo the ſurface turned towards the eye is named the ORBITARY PROCESS of the ſphenoid bone, or ORBITARY PLATE of the great ala.

The ſurface of the great wing which looks backward receives the middle lobe of the cerebrum and is called the CEREBRAL FOSSA.

2. The lower, or back part of this bone runs out into a narrow point, which ſinks in under the petrous portion of the temporal bone, and being ſharp pointed, it is named the SPINOUS PROCESS. It is very remarkable for a ſmall hole which permits the great artery of the dura mater to enter.

3. The point of this ſpinous proceſs projects in the form of a very ſmall peak, which will hardly be found

by the ſtudent. It projects from the baſis of the ſkull juſt within the condyle of the lower jaw, and being a ſmall point, like the point of the ſtylus, or iron-pen, it alſo is named STYLOID PROCESS.

4. The LESSER WING OF INGRASIAS, next attracts the eye. It is that part of the bone which unites (by harmonia) with the orbitary plate of the frontal bone, and with the æthmoid bone.

5. This leſſer wing projects laterally into the TRANSVERSE SPINOUS PROCESS.

6. 7. The PTEREGOID PROCESSES *, are four in number, two on either ſide. They are thoſe proceſſes, upon which (with the ſpinous proceſs) the bone naturally ſtands, and which, when we compare it with a bat, repreſent the legs; one of each ſide, is named external pteregoid, the other is named the internal pteregoid proceſs.

Each EXTERNAL PTEREGOID PROCESS is thin and broad, and extends farther backwards. Each INTERNAL PTEREGOID proceſs, is taller and more ſlender and not ſo broad. It has its end riſing higher than the other, and tipped with a ſmall neat hook, named the hook of the pteregoid proceſs, (viz. the HAMULAR PROCESS.) The inner pteregoid proceſſes, form the back of the noſtrils. The hook of the pteregoid proceſs, is called the hook of the palate, of which it forms the backmoſt point. The muſculus circumflexus vel tenſor pallati, riſing from the mouth of the Euſtachian tube, turns with a ſmall tendon round this hook, like a rope over its pully; and the great muſcles of the lower jaw, the only ones for moving it ſideways, or for its grinding motions, ariſe from the external pteregoid proceſſes.

8. The AZYGOUS PROCESS †, is ſo named, from its being ſingle, becauſe it is ſeated in the centre of the bone,

* There is ſome confuſion in this name, ſince pteregoid ſignifies aliform, or wing-like proceſſes.

† Azygous is a term, which is applied to ſuch parts as have no fellow; becauſe almoſt always the parts on one ſide of the body, are balanced by ſimilar and correſponding parts on the other ſide.

bone, ſo that it can have no fellow. It ſtands perpendicularly downwards and forewards, over the centre of the noſe, and its chief uſe is to give a firm ſeat or inſertion for the vomer or bone, which forms the ſeptum. The vomer, or proper bone of the partition, ſtands with a ſplit edge, aſtride over this proceſs, ſo as to have a very firm ſeat. A kind of union which has been called *gomphoſis*.

9. 10. The CLYNOID PROCESSES, have, like many parts of the human body, a very whimſical name, very ill ſuited to expreſs their form; for it is not eaſy, in this inſtance, to acknowledge the likeneſs of four little knobs, to bed-poſts; yet the clynoid proceſſes are very remarkable. The two ANTERIOR CLYNOID PROCESSES are ſmall bumps, rather ſharp, projecting backwards, and terminating in two flat projecting points. The POSTERIOR CLYNOID PROCESSES, riſe about an inch further backwards and are, as it were, oppoſed to the others. They riſe in one broad and flat proceſs, which divides above into two points, ſmall and round, or knobby at their points; and they look forwards towards the anterior clynoid proceſſes.

11. The laſt proceſs, is the TUBERCULUM OLIVARE, which is an eminence betwixt the anterior clynoid proceſs and before the *ſella turcica*.

The SELLA TURCICA, EPHIPPIUM, or Turkiſh ſaddle, is the ſpace encloſed by theſe four proceſſes, and is well named. The ſella turcica, ſupports the pituitary gland, an appendage of the brain, the uſe of which is unknown. The carotid arteries, riſe up by the ſides of the ſella turcica, and mark its ſides with a broad groove. The optic nerves lie upon a groove at the fore part of the ſella turcica, betwixt the two anterior clynoid proceſſes; and ſometimes the two anterior proceſſes, ſtretch backwards, till they meet the poſterior ones, and form an arch, under which, the carotid

When they ſtand in the centre of the body, or are otherwiſe ſingle, we call them azygous, and ſo the azygous proceſs of the æthmoid and ſphenoid, and other bones; or the azygous vein, which runs in the centre of the thorax, and is ſingle.

artery

artery paſſes. Often the poſterior clynoid knobs cannot be fairly diſtinguiſhed ; ſince in many ſkulls, they form but one broad proceſs.

This bone has alſo its cells, for all that part which we call the body of the bone, all the ſella turcica, that ſpace which is betwixt the clynoid proceſſes within and the azygous proceſs without, is hollowed into one large cell, divided with a middle partition. It is indeed, leſs regular than the other cells ; it is ſometimes very large, ſometimes it is not to be found ; it has other trifling varieties which it were idle to deſcribe. As it communicates with the æthmoid cells, it probably performs one office with them, is almoſt a continuation of them, ſo that when any one leſs or awanting, the others are proportionally larger.

HOLES.—The ſphenoid bone, is ſo placed in the very centre of the ſkull, that its holes tranſmit the principal nerves of the ſkull, and it bears the marks of the chief arteries.

1. The OPTIC HOLES, are large, round holes, juſt under each anterior clynoid proceſs. We trace the optic nerves by a large groove into each optic hole ; and an artery goes along with them, named the ophthalmic artery, nearly the ſize of a crow-quill, twiſting round the optic nerve, and giving arteries to the eye-lids, muſcles, and lachrymal gland, but moſt eſpecially to the ball and humours of the eye itſelf. This ocular or ophthalmic artery comes off from the great carotid, while it lies by the ſide of the ſella turcica ; and it is a branch again of this ocular artery, which goes out upon the forehead, forming the ſuperciliary notch, or hole.

2. The FORAMEN LACERUM, is next in order, and is ſo named, becauſe it is a wide ſlit. It is alſo called ſuperior orbitary fiſſure. The foramen lacerum, is wide near the ſella turcica, grows gradually narrower, as it goes out towards the temple, till it terminates almoſt in a ſlit. The upper line of the foramen lacerum is formed by the tranſverſe ſpinous proceſs, extending outwards, ſharp and flat.

 The

The nerves of the ſkull are counted from before backwards. There are nine nerves, proper to the ſkull; the 1ſt, or olfactory nerve, perforates the cribriform bone; the 2d, or optic nerve, paſſes through the optic hole; the 3d, 4th, part of the 5th, and 6th pairs of the nerves, paſs through this foramen lacerum, or wide hole, to go alſo into the eye. The optic nerve, forms the proper organ of viſion. The ſmaller nerves of the 3d, 4th, 5th, and 6th pairs, go to animate its muſcles and, paſſing through the orbit, to mount upon the forehead, or go downwards into the noſe.

3. The FORAMEN ROTUNDUM, is named from its round ſhape. The foramen opticum, is indeed round, but it has already got an appropriated name. Now to give the young anatomiſt a regular notion of this, and of the next hole, we muſt enumerate the branches of the 5th pair. The fifth nerve of the brain, is as broad as the little finger, and lies by the ſide of the ſella turcica, where it divides into three leſſer nerves, which are called branches of the 5th pair. The firſt branch of the 5th pair is deſtined for the eye; the ſecond branch of the 5th pair for the upper jaw; the third branch of this 5th pair for the lower jaw: ſo the firſt branch of the 5th pair paſſes through the foramen lacerum to the eye; the ſecond branch of the 5th pair paſſes through the foramen rotundum to the upper jaw; the third branch of this great nerve paſſes through the foramen ovale, to the lower jaw; and if we had any faith in the doctrines of nervous ſympathy, we ſhould ſay, here is a wide ſympathy provided among the nerves of the eye, the face, and the lower jaw.

The foramen rotundum then, is a hole exactly round, pretty large, opening immediately under the inner end of the foramen lacerum, and tranſmitting the ſecond branch of the 5th pair of nerves to the upper jaw.

4. The FORAMEN OVALE, is an oval hole, larger than the foramen rotundum; about half an inch behind it; and tranſmitting the third branch of the 5th pair to the ower jaw.

5. The

5. The FORAMEN SPINALE, or SPINOUS HOLE, is a very ſmall round hole, as if made with a large pin; is in the very point of the ſpinous proceſs: is one third of an inch behind the oval hole, and tranſmits the ſmall artery, leſs than a crow-quill, which conſtitutes the chief artery of the dura mater, viz. that artery, which makes its impreſſion upon the parietal bone.

6. There is ſtill another hole, which tranſmits a nerve curious in this reſpect, that it is not going out from the ſkull but returning into it; for the ſecond branch of the 5th pair, or the ſuperior maxillary nerve, ſends a ſmall branch backwards, which having come within the ſkull, enters the temporal bone, and goes to join itſelf to the portio dura of the 7th pair, and in its way gives a ſmall branch, to help out the ſlender beginning of the great ſympathetic nerve. This retrogade branch of the maxillary nerve, gets back again into the ſkull, by a hole which is found, juſt under the root of each pteregoid proceſs, whence it is named PTEREGOID HOLE *: or by many, is named after its diſcoverer, the VIDIAN HOLE †. This hole is almoſt hidden, under the point of the petrous bone, is not to be ſeen unleſs in the ſeparated bones, and is nearly of the ſize of the ſpinous hole.

If there are found ſome minute holes, about the ſella turcica, they are the marks of ſome blood veſſels entering the bone to nouriſh it.

CHAP. IV.

OF THE BONES OF THE FACE AND JAWS.

THE face is compoſed of a great number of ſmall bones, which are grouped together, under the common name of upper jaw. There are ſix bones on

* This retrograde twig, is the little nerve, which perforates the os petroſum on its fore part.

† Vidus Vidius, a profeſſor of Paris, and phyſician to Francis the Firſt.

either ſide of the face; but as their names could convey no diſtinct notion of the uſes, forms, or places of theſe bones, to enumerate them were but waſte of time: they have indeed ſutures, and their ſutures have been very regularly enumerated; but theſe bones meet each other by ſuch thin edges, that no indentation nor proper ſuture is formed. None of theſe ſutures run for any length, or are of any note, therefore I have only this to ſay, concerning the ſutures of the face, that they are acknowledged to be purely a conſequence of the oſſification having begun in many points: no particular deſign of nature has been ſuppoſed. The ſutures, if they require names, are to be named after the bones which they unite together.

OSSA NASI.—The oſſa naſi are ſmall bones, rather thin, having no cancelli, being merely firm and condenſed plates. They are convex outwardly, ſo that the two together form nearly an arch. They are oppoſed to each other by a pretty broad ſurface, ſo that their thin arch is firm. They have a flat rough ſurface, by which they are laid upon the rough ſurface of the frontal bone; ſo that there alſo their connection is ſtrong. They are encloſed by a branch of the upper jaw-bone, which, ſtretching upwards, is named its naſal proceſs: and they lie with their edges under it in one part, and above it in another, in ſuch a way that they cannot eaſily be forced in. Laſtly, their lower-edge is rough, for the firm attachment of the cartilages of the noſe; and their loweſt point, or that where the bones of the noſe and the griſtles of the noſe are joined, is the moſt prominent point (or, as it is vulgarly called, the bridge) of the noſe; from which connection, notwithſtanding its firmneſs, the cartilages are ſometimes luxated.

Os UNGUIS, ſo named from its being of the ſize and ſhape of a nail; or ſometimes named the OS LACHRYMALE, from its holding the duct which conveys the tears, is that thin ſcale of bone which I have deſcribed as belonging to the os æthmoides. It is commonly deſcribed

ſcribed as a diſtinct bone; it is a thin flat bone, a ſingle ſcale, without any cancelli, having only one ſharp ridge upon it; it forms a groove for lodging the lachrymal ſac, and is of courſe found in the inner angle of the eye, at its forepart, and juſt touching the top of the noſe. One half of this bone is behind the groove, and there the eye rolls upon it. One half of it is occupied by the groove for the naſal duct; and the other ſide of the groove is formed by the riſing branch or naſal proceſs, as it is called, of the upper jaw-bone. The os unguis is delicate, and eaſily broken, being as thin as a ſheet of paper. It is this bone which is pierced in the operation for the fiſtula lachrymalis, which is eaſily done, almoſt with a blunt ſteel or probe; and the chief caution is to perforate in the place of the groove, as that will lead into the noſe, and not behind it, which would carry the perforating inſtrument into the æthmoidal ſinuſes, and perhaps wound the ſpongy bone; nor more foreward, as that would be ineffectual from the ſtrength of the naſal proceſs of the maxillary bone.

This bone ſeems peculiarly liable to caries, which is perhaps the nature of all theſe thin bones; for as they have no marrow, they muſt depend entirely on their perioſteum, which they are no ſooner robbed off than they die.

Ossa maxillaria superiora.—The upper jaw-bones are particularly worthy of notice; for here we find all that is curious in the face, even to its ſize and ſhape. The upper jaw-bones are of a very great ſize, forming as it were the foundation or baſis of the face. They ſend a large branch upwards, which forms the ſides of the noſe; a broad plate goes backwards, which forms the roof of the palate. There is a circular projection below, which forms the alveoli, or ſockets of the teeth. The upper jaw-bones are quite hollow within, forming a very large cavity, which is capable of containing an ounce of fluid, or more; and the ſize of this cavity ſeems to determine the height of the cheek-bone, and the form of the face; and the diſeaſed enlargement of this cavity raiſes the cheek-bone, leſſens the

eye, and deforms the face in a very extraordinary degree.

Theſe proceſſes, and this cavity of the bone, are what deſerve moſt particular notice.

The ſurfaces or plates of the bone are theſe, 1. External or *malar* ſurface, 2. The ſuperior or *orbital*, 3. The internal or *naſal*, 4. The inferior or *palatine*.

1. The firſt proceſs is the NASAL PROCESS, which extends upwards, to form the ſide of the noſe. It is arched outwards, to give the noſtrils ſhape. Its ſides ſupport the naſal bones; and the cartilages of the alæ naſi, or wings of the noſe, are fixed to the edges of this proceſs.

2. A plate of this bone is called the orbitary proceſs. This thin plate is the roof of the great cavity, which occupies this bone entirely. It is at once as a roof to the antrum maxillare, and as a floor for the eye to roll upon. There is a wide groove along the upper ſurface of this plate, in which the chief branch of the upper maxillary nerve lies: and this nerve, named infra orbitary nerve from its lying thus under the eye, comes out by a hole of the jaw-bone under the eye, which is named infra orbitary hole. And thus the nerve appearing upon the cheek, becomes a nerve of the face.

3. This great bone is the baſis upon which the cheek-bone ſtands; and that it may have a firm place, there is a rough and (as anatomiſts call it) ſcabrous ſurface, which makes a very firm ſuture with the cheek bone; and as this ſurface riſes a little, it is named the MALAR PROCESS.

4. From the lower circle of the upper bone, there projects a ſemi-circle of bone, which is for lodging the teeth of the upper jaw. This circle of bone is as deep as the fangs of the teeth are long. And it may be very truly named a proceſs (PROCESSUS ALVEOLARIS), ſince it does not exiſt in the fœtus, nor till the teeth begin to be formed; ſince it grows along with the teeth, and is abſorbed and carried clean away when in old age the teeth fall out. The ſides of the ſockets in which the teeth are lodged are extremely thin, and

ſurround

ſurround them cloſely. The teeth are ſo cloſely embraced by their ſockets, and we are ſo far from being poſſeſſed of any inſtrument by which they can be pulled perpendicularly out, that the ſockets can ſeldom eſcape, they are broken or ſplintered in perhaps one of four extractions, even by the moſt dextrous artiſts in that line.

5 The PALATE PROCESS is a plate of bone which divides the noſe from the mouth, conſtituting the roof of the palate, and the floor or bottom of the noſtrils. This plate is thinner in its middle, and thicker at either edge: thus, it is thick where it firſt comes off from the alveolar proceſs; it is thin in its middle; and it is again thick where it meets its fellow of the oppoſite ſide. For at the place where the two upper jaw-bones meet, the palate-plate is turned upwards, ſo that the two bones are oppoſed to each other in the middle of the palate by a broad flat ſurface, which cannot be ſeen but by ſeparating the bones. This ſurface is ſo very rough, that the middle palate ſuture almoſt reſembles the ſutures of the ſkull; and the maxillary bones are neither eaſily ſeparated, nor eaſily joined again. This meeting of the palate-plates by a broad ſurface, makes a riſing ſpine, or ſharp ridge, towards the noſtrils, ſo that the broadneſs of the ſurface by which theſe bones meet ſerves a double purpoſe; it joins the bones ſecurely, and it forms a ſmall ridge upon which the ſplit edge of the vomer, or partitition of the noſe, is planted. Thus we find the palate-plate of the maxillary bones conjoined, forming almoſt the whole of the palate, while what are properly called the palate bones form a very ſmall ſhare of the back part only. As theſe thinner bones of the face have no marrow, they are nouriſhed by their perioſteum only; they are of courſe perforated with many ſmall holes. A great many minute holes are found along the palate-plate, about the place of the ſockets, and indeed all over the maxillary bones: and this is particular in the palate, that the hard membrane, or covering of it, is fixed

to the bony plate by many rough tubercles, and even by ſmall hooks, which are eaſily found in the dried bone.

6. Since we are deſcribing the plates of the bone as proceſſes, we ought to enumerate the *facies interna naſalis* as an INTERNAL NASAL PLATE. This is the ſide of the bone which is towards the cavity of the noſe, on which the lower ſpongy bone hangs, and which is perforated to allow a communication betwixt the great cell and the noſe.

7. The ANTRUM MAXILLARE, or cavity of the jaw-bone, is commonly named ANTRUM HIGHMORIANUM, after its diſcoverer, Highmore. We have gone round the antrum on all its ſides, in deſcribing theſe proceſſes of the bone: the palate-plate makes the floor of the antrum; the orbitary proceſs makes its roof; the cheek, quite up from the ſockets of the teeth to the lower part of the eye, forms its walls or ſides: ſo that when the antrum enlarges, it is the cheek that becomes deformed; and when we deſign to open the antrum, we either perforate the cheek, to pull one of the teeth. The antrum is round towards the cheek, but it has a flat ſide towards the noſe; it is divided from the cavity of the noſtril by a flat and very thin plate of bone; it ſeems in the naked ſkull to have a very wide opening; but in the ſkull, covered with its ſoft parts, we find the antrum almoſt cloſed by a membrane which ſtretches over the opening, and leaves but one or two very ſmall holes, of the ſize of the ſmalleſt pea, by which, perhaps, the reverberation of ſound in the antrum is more effectual in raiſing the voice, and by which ſmall hole, the mucus, which is ſecreted in the antrum, drops out into the noſe. The cavity of the antrum, like the inner ſurfaces of the noſtrils, is covered with a membrane, and is bedewed with mucus; and the mucus drops more or leſs freely in various poſitions of the head. Sometimes by cold, or other accidents, inflammations and ſwellings of the membrane come on; the holes are cloſed; the drain of matter is ſuppreſſed and confined within, and the cheek ſwells. Perhaps there

there may be ſome particular diſeaſe of the membrane with which the cavity is lined, or of the bone itſelf: in one way or other, diſeaſes of this cavity, and collections of matter, dreadful pain and caries of the bone, are very frequent: then the cheeks riſes; the face is irrecoverably deformed. Sometimes the matter makes its way by the ſides of the teeth, or at laſt it burſts through the bones, makes an ulcer in the cheek; and then there is a natural cure, but ſlow and uncertain. There is no very ſure mark of this diſeaſe; it may be known by an attentive retroſpect of all the circumſtances. The diſeaſe is not to be eaſily nor certainly diſcovered; but a very long continued tooth-ache, an uncommon degree of pain, or greater affection of the eye, with a ſwelling and redneſs, and gradual riſing of the cheek, are very ſuſpicious ſigns. The pulling of the ſecond or third of the grinding teeth, often brings a ſplinter away with it, which opens a road for the matter to flow; or though there be no breach of the ſocket, often the confined matter follows the tooth, becauſe not unfrequently the longer fangs of the grinders naturally penetrate quite into this cavity of the jaw: if the matter ſhould not flow, the floor of the antrum is eaſily perforated, by introducing a ſharp ſtillet by the ſocket of the tooth that is pulled. The flow of the matter gives relief, and injections complete the cure. But as this opening is ſometimes a cure, it is ſometimes alſo a diſeaſe; for the breaking of a ſocket, ſometimes opening a way into this antrum, there follows inflammation of its internal ſurface, a running of matter, and ſometimes caries of the bone.

HOLES.—There is only one perfect hole in this bone; but, by its union with other bones, it forms four more: 1. The INFRA-ORBITARY hole, for tranſmitting the infra-orbitary nerve from the bottom of the eye, is the opening of the canal which comes along under the eye. It is juſt under the margin of the orbit, or ſometimes the nerve which it tranſmits, divides, and makes two ſmaller holes in its paſſage upon the cheek. A hole in the palate-plate, which belongs equally to each of the

palate

palate bones may be counted the ſecond foramen; for it is betwixt the two bones in the fore part, or beginning of the palate ſuture behind the two firſt cutting teeth. This hole is named FORAMEN INCISIVUM, as opening juſt behind the inciſive or cutting teeth; or it is named ANTERIOR PALATINE HOLE, to diſtinguiſh it from one in the back of the palate. This hole is large enough to receive the point of a quill; it is ſingle towards the mouth; but towards the noſe, it has two large openings, one opening diſtinctly into each noſtril.

3. But it will be well to explain here a third hole, which is common to the maxillary with the proper palate-bones. It is formed on the back part of the palate (one on either ſide), in the ſuture which joins the palate-bones to the jaw-bones: it is named POSTERIOR PALATINE HOLE: It is as large as the anterior palatine hole, but it ſerves a much more important purpoſe; for the upper maxillary nerve ſends a large branch to the palate, which branch comes down behind the back of the noſtril, perforates the back of the palate by the poſterior palatine hole, and then goes forward in two great branches along the palate. Thus the chief, or, we might ſay, the only nerves of the palate comes down to it through theſe poſterior palatine holes: The uſe of the anterior palatine hole has long been a problem. It looks almoſt as if it were merely deſigned for giving the ſoft palate a ſurer hold upon the bone; but Scarpa, the Italian anatomiſt, deſcribes a nerve from the 5th pair, taking its courſe in this way to the ſoft palate.

4. The fourth foramen is formed by the union of the lower ſpongy bone, to the internal naſal plate of the bone; and is for the tranſmiſſion of the lachrymal duct.

5. The LATERAL ORBITARY FISSURE is a ſlit formed by this bone and the ſphenoid bone; it is a communication betwixt the orbit and temple.

The whole ſurface of the bone which forms the antrum is perforated with frequent ſmall holes, eſpecially towards its back part, tranſmitting ſmall arteries and nerves to the teeth; and the back part of the antrum

forms

forms with the orbitary part of the ſphenoid bone a ſecond foramen lacerum for the eye; an irregular opening towards the bottom of the ſocket, which is for the accumulation of fat, not for the tranſmiſſion of nerves; and it is from the waſting of this fat, taken back into the ſyſtem, that the eye ſinks ſo remarkably in fevers, conſumptions, and ſuch other diſeaſes as waſte the body.

The OSSA PALATI, or PALATE BONES—are very ſmall, but have ſuch a number of parts, and ſuch curious connections as are not eaſily explained. They ſeem to eke out the ſuperior maxillary bones, ſo as to lengthen the palate, and complete the noſtrils behind: they even extend upwards into the ſocket, ſo as to form a part of its circle; although, in looking for them upon the entire ſkull, all theſe parts are ſo hidden, that we ſhould ſuppoſe the palate bones to be of no greater uſe nor extent than to lengthen the palate a little backwards.

The parts of the palate bone are theſe:

1. The PALATAL PLATE, or proceſs of the palate bone, whence it has its name, lies horizontal in the ſame level with the palatal proceſs of the jaw bone, which it reſembles in its rough and ſpinous ſurface, in its thinneſs; in its being thinner in the middle, and thicker at either end; in its being oppoſed to its fellow by a broad ſurface, which completes the MIDDLE PALATE SUTURE; and it is connected with the palate proceſs of the jaw, by a future reſembling that by which the oppoſite bones are joined; but this future, going acroſs the back part of the palate, is named the TRANSVERSE PALATE SUTURE. Where the two palate bones are joined, they run backwards into an acute point; on either ſide of that middle point, they make a ſemi-circular line, and again run out into two points behind the grinding teeth of each ſide. By this figure of the bones, the back line of the palate has a ſcolloped or waved form. The velum palati, or curtain of the palate, is a little arched, following the general line

line of the bones; the uvula, or pap, hangs exactly from the middle of the velum, taking its origin from the middle projecting point of the two bones; and a small muscle, the azygos uvulæ, runs down in the middle of the velum, taking its origin from this middle.

2. The small projecting point of the palate bone, just behind the last grinding tooth, touches the pteregoid process of the sphenoid bone, it is therefore named the PTEREGOID PROCESS of the palate bone; but it is so joined with the pteregoid process of the sphenoidal bone, that they are not to be distinguished in the entire skull. The posterior pteregoid hole, or third hole of the palate, is just before this point.

3. The NASAL PLATE, or PROCESS, is a thin and single plate; rises perpendicularly upwards from the palate; lies upon the side and back part of the nostrils, so as to form their opening backwards into the throat; it is so joined to the upper jaw-bone, that it lies there like a sounding-board upon the side of the antrum Highmorianum, and completes that cavity forming the thin partition betwixt it and the nose.

4. This nasal process extends thus up from the back arch of the palate, to the back part of the orbit; and, though the nasal plate is very thin and delicate in its whole length, yet, where it enters into the orbit, it is enlarged into an irregular kind of knob of a triangular form. This knob is named its ORBITARY PROCESS; or, as the knob has two faces looking two ways in the orbit, it is divided sometimes (as by Monro the father), into two orbitary processes, the anterior and posterior; the anterior one is the chief. This orbitary process, or point of the palate bone, being triangular, very small, and very deep in the socket, is not easily discovered in the entire skull.

5. This orbitary process, is most commonly hollow or cellular, and its cells are so joined to those of the sphenoid bone, that it is the palate bone that shuts the sphenoid cells, and the sphenoid and PALATINE CELLS of each side, constitute but one general cavity.

The

The OSSA SPONGIOSA, or TURBINATA INFERIORA, are ſo named, to diſtinguiſh them from the upper ſpongy bones, which belong to the os æthmoides; but theſe lower ſpongy bones, are quite diſtinct, formed a part, and connected in a very ſlight way with the upper jaw-bones.

The OSSA SPONGIOSA INFERIORA, are two bones, much rolled or convoluted, very ſpongy, much reſembling puff-paſte, having exactly ſuch holes, cavities, and net-work, as we ſee in raiſed paſte, ſo that they are exceedingly light. They lie rolled up, in the lower part of the noſe; are particularly large in ſheep; are eaſily ſeen either in the entire ſubject or in the naked ſkull. Their point forms that projection, which we touch with the finger in picking the noſe; and from that indecent practice, very often ſerious conſequences ariſe for in many inſtances, polypi of the lower ſpongy bones, which can be fairly traced to hurts of this kind, grow ſo, as to extend down the throat, cauſing ſuffocation and death.

One membrane conſtitutes the univerſal lining of the cavities of the noſe, and the coverings of all the ſpongy bones. This continuity of the membrane, prevents our ſeeing in the ſubject, how ſlightly the ſpongy bones are hung; but in the bare and diſſected ſkull, we find a neat ſmall HOOK upon the ſpongy bone, by which it is hung upon the edge of the antrum maxillare; for this lower ſpongy bone, is laid upon the ſide of the antrum. ſo as to help the palate bone, in cloſing or covering that cavity from within. One END of the ſpongy bone, rather more acute, is turned towards the opening of the noſtril, and covers the end of the lachrymal duct: the other END of the ſame bone, points backwards towards the throat. The curling plate, hangs down into the cavity of the noſtril, with its arched ſide towards the noſe. This ſpongy bone, differs from the ſpongy proceſs of the æthmoid bone, in being leſs turbinated or complex, in having no cells connected with it, and perhaps it is leſs directly related to the organ of ſmell. If polypi

arife from the upper fpongy bone, we can ufe lefs freedom, and dare hardly pull them away, for fear of injuring the cribriform plate of the æthmoid bone. We are indeed, not abfolutely prohibited from pulling the polypi, from the upper fpongy bone; but we are more at eafe, in pulling them from the lower one, fince it is quite an infulated bone. When peas, or any fuch foreign bodies, are detained in the nofe, it muft be from fwelling, and being detained, among the fpongy bones.

The fpongy bones are not abfolutely limited in their number: there is fometimes found betwixt thefe two, a third fet of fmall turbinated bones, commonly belonging to the æthmoid bone.

VOMER.—The nofe is completed by the vomer which is named from its refemblance to a plough fhare and which divides the two noftrils from each other: It is a thin and flender bone, confifting evidently of two plates, much compreffed together, very denfe, and ftrong, but ftill fo thin, as to be tranfparent. The two plates of which the vomer is compofed, fplit or part from each other at every edge of it, fo as to form a groove on every fide. 1. On its upper part, or, as we may call it, its bafe, by which it is fixed to the fkull, the vomer has a WIDE GROOVE, receiving the projecting point of the æthmoid and fphenoid bones: thus it ftands very firm and fecure, and capable of refifting very violent blows. 2. Upon its lower part its groove is narrower, and receives the rifing line in the middle of the palate-plate, where the bones meet to form the palate future. At its fore-part, it is united by a ragged furface, and by fomething like a groove to the middle cartilage of the nofe; and, as the vomer receives the other bones into its grooves, it is in a manner, locked in on all fides: it receives fupport and ftrength from each; and if the vomer and its cartilage, fhould feem too flender a fupport, for the fabric of the nofe, let it be remembered, that they are all firmly connected, and covered by one continuous membrane, which is thick

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and ſtrong, and that this is as a perioſteum, or rather like a continued ligament, which increaſes greatly the thickneſs and the ſtrength of every one of theſe thin plates. The vomer, in almoſt every ſubject, bends much towards one or other noſtril, ſo as ſometimes to occaſion no ſmall apprehenſion, when it happens to be firſt obſerved.

OS MALAE, or the bone of the cheek, is eaſily known and is a very unimportant one. It is that large ſquare bone which forms the cheek: it has four diſtinct points, which anatomiſts have choſen to demonſtrate, with a very ſuperfluous accuracy. 1. The UPPER ORBITARY proceſs, ſtands higheſt, running upwards to form part of the ſocket, the outer corner of the eye, and the ſharp edge of the temple. 2. The INFERIOR ORBITARY PROCESS, which is juſt oppoſite to this, forming the lower part of the orbit, and the edge of the cheek. 3. The MAXILLARY PROCESS, is that broad and rough ſurface, by which it is joined to the upper jaw-bone. 4. Is the one the beſt entitled to the name of proceſs, becauſe it ſtands out quite inſulated, and goes outwards and backwards to unite with the temporal bone, in forming the zygoma or temporal arch; it is named the ZYGOMATIC PROCESS. 5. That plate, which goes backwards to form the floor of the orbit, is named the INTERNAL ORBITARY PROCESS. This bone has no holes, except ſuch minute ones, as tranſmit arteries, merely for the nouriſhment of the bone itſelf.

OS MAXILLAE INFERIORIS.—The lower jaw-bone, is likened to a horſe ſhoe, or to a creſcent, or to the letter U, though we need be under no anxiety about reſemblances, for a form ſo generally known. There is ſuch an infinite complication of parts ſurrounding the jaw, of glands, muſcles, blood-veſſels, and nerves, that it were endleſs to give even the ſlighteſt account of theſe. They ſhall be reſerved each for its proper place, while I explain the form of the lower jaw, in the moſt ſimple and eaſy way. The lower jaw is divided into the chin, viz. the circle betwixt the two mental foramina;

foramina; the base extending backward to the angle; and the upright portion of the bone.

1. The fore part, or chin, is in a handsome and manly face, very square; and this portion is marked out by this squareness, and by two small holes, one on either side, by which the nerves of the lower jaw come out upon the face.

2. The base of the jaw, is a straight and even line, terminating the outline of the face. It is distinctly traced all along, from the first point of the chin, backwards to the angle of the jaw. Fractures of this bone, are always more or less transverse, and are easily known by the falling down of one part of this even line, and by feeling the crashing bones when the fallen part is raised. Such fractures happen from blows or falls; but not by pulling teeth, for the sockets of the teeth bear but a small proportion to the rest of the jaw; even in children, this cannot happen; for in them the teeth have shorter roots, and have no hold nor dangerous power over the jaw: though (as I have said) the sockets often suffer, the jaw itself never yields.

3. The angle of the jaw, is that corner where the base of the jaw ends, where the bone rises upwards, at right angles, to be articulated with the head. This part also, is easily felt, and by it we judge well of the situation of veins, arteries, and glands, which might be in danger of being cut, in wounds or in operations. There are two processes of the jaw, of particular importance, the coronoid or horn-like process, for the insertion of its strong muscles, especially of the temporal muscle, and the condyloid or hinge process, by which it is jointed with the temporal bone.

4. The CORONOID PROCESS, named from its resemblance to a horn, is, like the rest of the jaw-bone, flat on its sides, and turned up with an acute angle, very sharp at its point, and when the bone is in its place lying exactly under the zygoma, or temporal arch. The temporal muscle runs under this arch, and lays hold on the coronary process, not touching it on one point only, but grasping it on every side, and all round. And the

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procefs is fet fo far before the articulation of the jaw, that it gives the mufcle great power. This procefs is fo defended by the temporal arch, and fo covered by muf-cles, that it cannot be felt without.

5. The CONDYLOID PROCESS, or the articulating pro-cefs of the jaw, is behind this. This alfo is of the fame flat form with the reft of the jaw. The condyle, or joint of the jaw-bone, is placed upon the top of the rifing branch. The condyle, or articulating head, is not round, but flat, of a long form, and fet acrofs the branch of the jaw. This articulating procefs is received into a long hollow of the temporal bone, juft under the root of the zygomatic procefs; fo that by the long form of the condyles, and of the cavity into which it is re-ceived, this joint is a mere hinge, not admitting of lateral nor rotatory motions, at leaft of no wider lateral motions than thofe which are neceffary in grinding the food; but the hinge of the jaw is a complex and very curious one, which fhall be explained in its proper place.

6. The ALVEOLAR PROCESS, or the long range of fockets for the teeth, refembles that of the upper jaw. The jaw, as the body grows, is flowly increafing in length, and the teeth are added in proportion to the growth of the jaws. When the jaws have acquired their full fize, the fockets are completely filled; the lips are extended, and the mouth is truly formed. In the decline of life, the teeth fall out, and the fockets are re-ab-forbed, and carried clean away, as if they had never been; fo that the chin projects, the cheeks become hollow, and the lips fall in, the fureft marks of old age.

7. The SPINA INTERNA, or internal tubercle of the lower jaw, is juft behind the fymphifis, or on the infide of the circle of the chin. It gives origin to mufcles which move the tongue and larynx.

The fucceffive changes of the form of the jaw are worthy of being mentioned once more; firft, that in the child, the jaw confifts of two bones, which are joined flightly together in the chin. This joining, or fym-

fymphyfis, as it is called, is eafily hurt, fo that in preternatular labours it is, according to the common method of pulling by the chin, always in danger, and often broken. During childhood the proceffes are blunt, and fhort, do not turn upwards with a bold and acute angle, but go off obliquely from the body of the bone. The teeth are not rooted, but fticking fuperficially in the alveolar procefs; and another fet lies under them, ready to pufh them from the jaws.

Secondly, That in youth, the alveolar procefs is extending, the teeth are increafing in number. The coronoid and articulating proceffes are growing acute and large, and are fet off at right angles from the bone. The teeth are now firmly rooted; for the fecond fet has come up from the body of the jaw.

Thirdly, In manhood, the alveolar procefs is ftill more elongated. The dentes fapientiæ are added to the number of the teeth; but often, by this, the jaw is too full, and this laft tooth coming up from the backmoft point of the alveolar procefs in either jaw, it fometimes happens, that the jaw cannot eafily clofe; the new tooth gives pain; it either corrupts, or it needs to be drawn.

Fourthly, In old age, the jaw once more falls flat; it fhrinks according to the judgment of the eye, to half its fize; the fockets are abforbed, and conveyed away; and in old age the coronoid procefs rifes at a more acute angle from the jaw bone, and by the falling down of the alveolar procefs, the coronoid procefs feems increafed in length.

HOLES.—The holes of the jaw are chiefly two:

1. A LARGE HOLE on the inner fide, and above the angle of the jaw, juft at the point where thefe two branches, the condyloid and the coronoid proceffes part. A wide groove from above downwards, leads to the hole; and the hole is, as it were, defended by a fmall point, or pike of bone, rifing up from its margin. This is the GREAT HOLE for admitting the LOWER MAXILLARY NERVE into the hollow of the jaw, where

it goes round within the circle of the jaw, diſtributing its nerves to all the teeth. But at the point where this chief branch of the nerve goes down into the jaw, another branch of the nerve goes forward to the tongue. And as nerves make an impreſſion as deep as that of arteries in a bone, we find here two grooves, firſt, one making the place of the great nerve, as it advances towards its hole; and, ſecondly, a ſmaller groove, marking the courſe of the leſſer branch, as it leaves the trunk, and paſſes this hole to go forward to the tongue.

Along with this nerve, the lower maxillary artery, a large branch, enters alſo by the hole; and both the nerve and the artery, after having gone round the canal of the jaw, emerge again upon the chin.

2. The ſecond hole of the lower jaw is that on the ſide of the chin, which permits the remains of the great nerve and artery (almoſt expended upon the teeth) to come out upon the chin; it is named the MENTAL HOLE.

CHAP. V.

OF THE TRUNK; OR, THE SPINE, THORAX, AND PELVIS.

THE ſpine is ſo named from certain projecting points of each bone, which, ſtanding outwards in the back, form a continued ridge; and the appearance of continuity is ſo complete, that the whole ridge is named ſpine, which, in common language, is ſpoken of as a ſingle bone. This long line conſiſts of twenty-four diſtinct bones, named vertebræ, from the Latin vertere, to turn. They conduct the ſpinal marrow, ſecure from harm the whole length of the ſpine, and ſupport the whole weight of the trunk, head and arms; they perform, at certain points, the chief turnings and bendings of the body; and do not ſuffer under the longeſt fatigue, or the greateſt weight which the limbs can bear. Hardly can any thing be more beau-

tiful or surprifing than this mechanifm of the fpine, where nature has eftablifhed the moft oppofite and inconfiftent functions in one fet of bones; for thefe bones are fo free in motion, as to turn continually, yet fo ftrong as to fupport the whole weight of the body; and fo flexible as to turn quickly in all directions, yet fo fteady within, as to contain and defend the moft material and the moft delicate part of the nervous fyftem.

The vertebræ are arranged according to the neck, back, and loins, and the number of pieces correfponds with the length of thofe divifions. The vertebræ of the LOINS are five in number, very large and ftrong, and bearing the whole weight of the body. Their proceffes ftand out very wide and free, not entangled with each other, and performing the chief motions of the trunk. The vertebræ of the BACK are twelve in number. They alfo are big and ftrong, yet fmaller than thofe of the loins; their proceffes are laid over each other; each bone is locked in with the next, and embarraffed by its connection with the ribs; this is therefore the fteadieft part of the fpine, a very limited motion only is allowed. The vertebræ of the NECK are feven in number; they are more fimple, and like rings; their proceffes hardly project; they are very loofe and free; and their motions are the wideft and eafieft of all the fpine.

The feven vertebræ of the neck, twelve of the back, and five of the loins, make twenty-four in all, which is the regular proportion of the fpine. But the number is fometimes changed, according to the proportions of the body; for, where the loins are long, there are fix vertebræ of the loins, and but eleven in the back; or the number of the pieces in the back is fometimes increafed to thirteen; or the neck, according as it is long or fhort, fometimes has eight pieces, or fometimes only fix.

GENERAL DESCRIPTION OF A VERTEBRA.—The general form, proceffes, and parts of the vertebra, are beft exemplified in a vertebra of the loins; for in it the body is large, the proceffes are right-lined, large, and ftrong;

ſtrong; the joint is complete, and all its parts are very ſtrongly marked. Every vertebra conſiſts of a body, which is firm for ſupporting the weight of the body, and hollow behind, for tranſmitting the ſpinal marrow; o two articulating proceſſes above, and two below, by which it is jointed with the bones which are above and below it; of two tranſverſe proceſſes, which ſtand out from either ſide of the bone, to give hold and purchaſe to thoſe muſcles which turn the ſpine; and of one proceſs, the ſpinous proceſs, which ſtands directly backwards from the middle of the bone; and theſe proceſſes being felt in diſtinct points all the way down the back, give the whole the appearance of a ridge; whence it has the name of ſpine.

1. The BODY of the VERTEBRA is a large maſs of ſoft and ſpongy bone; it is circular before, and flat upon the ſides. It is hollowed into the form of a creſcent behind, to give the ſhape of that tube in which the ſpinal marrow is contained. The body has but a very thin ſcaly covering for its thick and ſpongy ſubſtance. It is tipped with a harder and prominent ring above and below, as a ſort of defence, and within the ring, the body of the vertebra is hollowed out into a ſort of ſuperficial cup, which receives the ligamentous ſubſtance by which the two next vertebræ are joined to it; ſo that each vertebra goes upon a pivot, reſembles the ball, and ſocket joints. And in many animals it is diſtinctly a joint of this kind.

1. The BODY is the main part of the vertebra to which all the other proceſſes are to be referred; it is the centre of the ſpine, and bears chiefly the weight of the body: it is large in the loins, where the weight of the whole reſts upon it, and where the movements are rather free: it is ſmaller in the vertebræ of the back, where there is almoſt no motion and leſs weight; and in the vertebræ of the neck, there is hardly any body; the vertebræ being joined to each other chiefly by the articulating proceſſes.

2. The ARTICULATING PROCESS is a ſmall projection, ſtanding out obliquely from the body of the vertebra,

with a ſmooth ſurface, by which it is joined to the articulating proceſs of the next bone; for each vertebra has a double articulation with that above and with that below. The bodies of the vertebræ are united to each other by a kind of ligament, which forms a more fixed, and rather an elaſtic joining; and they are united again by the articulating proceſſes, which makes a very moveable joint of the common form. The articulating proceſſes are ſometimes named oblique proceſſes, becauſe they ſtand rather obliquely. The upper ones are named the aſcending oblique proceſſes, and the two lower ones are named the inferior or deſcending oblique proceſſes.

3. The SPINOUS PROCESSES are thoſe which project directly backwards, whoſe points form the ridge of the back, and whoſe ſharpneſs gives the name to the whole column. The body of each vertebra ſends out two arms, which, meeting behind, form an arch or canal for the ſpinal marrow; and from the middle of that arch, and oppoſite to the body, the ſpinous proceſs projects. Now the ſpinous, and the tranſverſe proceſſes, are as ſo many handles and levers by which the ſpine is to be moved, which, by their bigneſs, give a firm hold to the muſcles, and, by their length, give them a powerful lever to work their effects by. The ſpinous proceſſes, then, are for the inſertion of theſe muſcles which extend and raiſe the ſpine.

4. The TRANSVERSE PROCESSES ſtand out from the ſides of the arms or branches which form this arch. They ſtand out at right angles, or tranſverſely from the body of the bone; and they alſo are as levers, and long and powerful ones for moving and turning the ſpine. Perhaps their chief uſe is not for turning the vertebræ, for there is no proviſion for much of a lateral motion in the lower part of the ſpine, but the muſcles which are implanted into theſe, are more commonly uſed in aſſiſting thoſe which extend and raiſe the ſpine.

Theſe, and all the proceſſes, are more diſtinct, prominent, and ſtrong; more direct, and larger in the

loins,

loins, and more eaſily underſtood, than in the vertebræ of any other claſs. But this prepares only for the deſcription of the individual vertebra, where we find a variety proportioned to the various offices, and to the degrees of motion which each claſs has to perform.

OF THE VERTEBRÆ OF THE LOINS.—I have choſen to repreſent the general form of a vertebra, by deſcribing one from the loins, becauſe of the diſtinctneſs with which all its parts are marked. In the lumbar vertebræ, the perpendicular height of the body is ſhort, the intervertebral ſubſtance is thicker than in the other parts of the ſpine, and the ſeveral proceſſes ſtand off from each other diſtinct and clear; all which are proviſions for a freer motion in the loins.

The BODY of a lumbar vertebra is particularly large, thick, and ſpongy, and its thin outer plate is perforated by many arteries going inwards to nouriſh this ſpongy ſubſtance of the bone. The length of the body is an inch, and the interſticial cartilage is nearly as long; ſo that the vertebræ of the loins preſent to the eye, looking from within the body, a large, thick, and maſſy column, fit for ſupporting ſo great a weight.

The SPINOUS PROCESS is ſhort, big, and ſtrong. It runs horizontally and directly backwards from the arch of the ſpinal marrow. It is flattened, and about an inch in breadth; and it is commonly terminated by a lump or nob, indicating the great ſtrength of the muſcles which belong to it, and the ſecure hold which they have.

The TRANSVERSE PROCESS is alſo ſhort, direct, and very ſtrong, going off horizontally from the ſide of the bone, terminated like the ſpinous, by a knotty point, where large muſcles are implanted.

The ARTICULATING PROCESSES of the lumbar vertebræ ſtand ſo directly upwards and downwards, that the name of oblique proceſſes cannot be applied here.

Of the VERTEBRÆ OF THE BACK.—The character of the vertebræ of the back is directly oppoſite to that of the

the loins. The BODIES of the vertebræ are ſtill large to ſupport the great weight of the trunk; but they are much longer than in the loins, and their intervertebral ſubſtance is thin, for there is little motion here. The SPINOUS PROCESSES in the vertebræ of the back, are very long and aquiline. They are broad at their baſis, and very ſmall or ſpinous at their further end; and in place of ſtanding perpendicularly out from the body, they are ſo bent down, that they do not form a prominent nor unſightly ſpine, but are ranged almoſt in a perpendicular line, that is, laid over each other, like the ſcales of armour, the one above touching the one below, by which the motions of theſe vertebræ are ſtill further abridged. And, laſtly, the TRANSVERSE PROCESSES, which are ſhort and knobby, in place of ſtanding free and clear out, like thoſe of the loins, are tramelled and reſtricted from motion, by their connection with the ribs; for the ribs are not merely implanted upon the bodies of the dorſal vertebræ, but they are further attached firmly by ligaments, and by a regular joint to the tranſverſe proceſs of each vertebra. Now the rib being fixed to the body of one vertebra, and to the tranſverſe proceſs of the vertebra below, the motions of the vertebræ are much curbed. And we alſo get another mark by which the dorſal vertebræ may be known, viz. that each vertebra bears two impreſſions of the rib which was joined to it, one on the flat ſide of its body, and the other on the fore part of its tranſverſe proceſs.

Of the VERTEBRÆ OF THE NECK.—The vertebræ of the neck depart ſtill farther from the common form. Their BODIES are flattened on their fore parts, ſo as to make a flat ſurface on which the windpipe and gullet lie ſmooth. The BODY is very ſmall in all the vertebræ of the neck. In the uppermoſt of the neck there is abſolutely no body; and the next to that has not a body of the regular and common form. There is not in the vertebræ of the neck, as in thoſe of the loins, a cup or hollow for receiving the intervertebral ſubſtance, but the ſurfaces of the body are flat or plain, and the

articulating

articulating proceſſes are oblique, and make as it were one articulation with the body; for the lower ſurface of the body being not hollow, but plain, and inclined forwards, and the articulating proceſſes being alſo plain, and inclined backwards, the two ſurfaces are oppoſed to each other, and the one prevents the vertebræ from ſliding forwards, and the other prevents it from ſliding backwards, while a pretty free and general motion is allowed. The SPINOUS PROCESSES of the neck are for the inſertion of many muſcles, and therefore they are ſplit. This bifurcation of the ſpinous proceſs is not abſolutely peculiar to the cervical vertebræ; for ſometimes, though rarely, the others are ſo: and it is only in the middle of the neck that even they are forked; for the firſt vertebra is a plain ring, without any tranſverſe proceſs, becauſe there are few muſcles attached to it; and the laſt vertebra of the neck is ſcarcely bifurcated, approaching to the nature of the dorſal vertebræ; for it is long and aquiline; is depreſſed towards the back, and is ſo much longer than the others, as to be diſtinguiſhed by the name of VERTEBRA PROMINENS.

The TRANSVERSE PROCESSES of the neck are alſo bifurcated, becauſe there are a great many ſmall muſcles inſerted into them alſo. But the moſt curious peculiarity of the tranſverſe proceſſes is, that each of them is perforated for the tranſmiſſion of the great artery, which is named VERTEBRAL ARTERY, becauſe it paſſes through theſe holes in the vertebræ which form altogether a bony canal for the artery. This artery, which is defended with ſo much care, is one of the chief arteries of the brain, for there are two only; and often when the other, the carotid, has been obſtructed this continues to perform its office.

So that the character of theſe cervical vertebræ is, that they are calculated for much free motion; and the marks by which they are diſtinguiſhed are, that the bodies are particularly ſmall; the articulating proceſſes oblique, with regard to their poſition, and almoſt plain on their ſurface. The ſpinous proceſs, which is

wanting in the uppermoſt vertebræ, is ſhort and forked in all the lower ones; the tranſverſe proceſs alſo is forked; and the tranſverſe proceſſes of all the vertebræ, except perhaps the firſt, are perforated near their extremities with the large hole of the vertebral artery.

ATLAS AND DENTATUS. — But among theſe vertebræ of the neck, two are to be particularly diſtinguiſhed, as of greater importance than all the reſt; for though the five lower vertebræ of the neck be oſſified and fixed, if but the two uppermoſt remain free, the head, and even the neck, ſeem to move with perfect eaſe.

The firſt vertebra is named ATLAS, perhaps, becauſe the globe of the head is immediately placed upon it; the ſecond is named DENTATUS or axis, becauſe it has an axis or tooth-like proceſs upon which the firſt turns.

The ATLAS has not the complete form of the other vertebræ of the neck, for its proceſſes are ſcarcely diſtinguiſhable: it has no body, unleſs its two articulating proceſſes are to be reckoned as a body: it is no more than a ſimple ring; it has no ſpinous proceſs; and its tranſverſe proceſs is not forked. The BODY is entirely wanting: in its place, the vertebra has a flat ſurface looking backwards, which is ſmooth and poliſhed by the rolling of the tooth-like proceſs; there is alſo a ſharp point riſing perpendicularly upwards towards the occipital bone, and this point is held to the edge of the occipital hole by a ſtrong ligament. The ſmooth mark of the tooth-like proceſs is eaſily found; and upon either ſide of it, there projects a ſmall point from the inner circle of the ring: theſe two points have a ligament extended betwixt them, called the tranſverſe ligament, which, like a bridge, divides the ring into two openings; one the ſmaller, for lodging the tooth-like proceſs, embracing it cloſely; the greater opening is for the ſpinal marrow: the ligament confines the tooth-like proceſs; and when the ligament is burſt by violence (as has happened), the tooth-like proceſs

broken loose, presses upon the spinal marrow; the head, no longer supported by it, falls forward, and the patient dies.

The ARTICULATING PROCESS may be considered as the body of this vertebra; for it is at once the only thick part, and the only articulating surface. This broad articulating substance is in the middle of each side of the ring; it has two smooth surfaces on each side, one looking upwards, by which it is joined to the occiput; and one looking directly downwards, by which it is joined to the second vertebra of the neck. The two upper articulating surfaces are oval, and slightly hollow to receive the occipital condyles: they are also oblique, for the inner margin of each dips downwards; the outer margin rises upwards; and the fore end of each oval is turned a little towards its fellow. Now, by the obliquity of the condyles, and this obliquity of the sockets which receive them, all rotatory motion is prevented, and the head performs, by its articulations with the first vertebra or atlas, only the nodding motions; and when it rolls, it carries the first vertebra along with it, moving round the tooth-like process of the dentatus. The articulation with the head is a hinge joint, in the strictest sense: it allows of no other motion than that backwards and forwards; the nodding motions are performed by the head upon the atlas, the rotatory motions are performed by the atlas moving along with the head, turning upon the tooth-like process of the dentatus.

Now the upper articulating surface of the atlas is hollowed to secure the articulation with the head; but the lower articulation, that, with the dentatus, being secured already by the tooth-like process of that bone, no other property is required in the lower articulating surface of the atlas, than that it should glide with perfect ease; for which purpose, it is plain and smooth; it neither receives, nor is received into the dentatus by any hollow, but lies flat upon the surface of that bone. It is also evident, that since the office of the atlas is to turn along with the head, it could not be fixed to the dentatus,

dentatus, in the common way, by a body and by intervertebral ſubſtance; and ſince the atlas attached to the head moves along with it, turning as upon an axis, it muſt have no SPINOUS PROCESS; for the projection of a ſpinous proceſs muſt have prevented its turning upon the dentatus, and would even have hindered, in ſome degree, the nodding of the head; therefore the atlas has a ſimple ring behind, and has only a ſmall knob or button where the ſpinous proceſs ſhould be. The TRANSVERSE PROCESS is not forked, but it is perforated with a large hole for the vertebral artery; and the artery to get into the ſkull, makes a wide turn, lying flat upon the bone, by which there is a ſlight hollow or impreſſion of the artery, which makes the ring of the vertebra exceedingly thin.

But the form of the dentatus beſt explains theſe peculiarities of the atlas, and this turning of the head.

The DENTATUS or AXIS, is ſo named from its projecting point, which is the chief characteriſtic of this bone. When the dentatus is placed upright before us, we obſerve, 1. That it is moſt remarkably conical, riſing all the way upwards, by a gradual ſlope, to the point of its tooth-like proceſs. 2. That the ring of the vertebra is very deep, that is, very thick in its ſubſtance, and that the opening of the ring for tranſmitting the ſpinal marrow is of a triangular form. 3. That its ſpinous proceſs is ſhort, thick, and forked; and that it is turned much downwards, ſo as not to interfere, in any degree, with the rotation of the atlas. 4. That its tooth-like proceſs, from which the bone is named, is very large, about an inch in length; very thick, like the little finger; that it is pointed; and that from this rough point a ſtrong ligament goes upwards, by which the tooth is tied to the great hole of the occipital bone. We alſo obſerve a neck or collar, or ſmaller part, near the root of the tooth-like proceſs, where it is graſped by the ring of the atlas; while the point ſwells out a little above; ſo that without the help of ligaments, it is almoſt locked in its place. We find this neck particularly

ticularly ſmooth; for it is indeed upon this collar that the head continually turns. And, 5. We ſee on either ſide of this tooth-like proceſs a broad and flat articulating ſurface, one on either ſide. Theſe articulating ſurfaces are placed like ſhoulders; and the atlas being threaded by the tooth-like proceſs of the dentatus, is ſet flat down upon the high ſhoulders of this bone, and there it turns and performs all the rotatory motions of the head.

OF THE MEDULLARY TUBE, AND THE PASSAGE OF THE NERVES.—All the vertebræ conjoined make a large canal of a triangular or roundiſh form, in which the ſpinal marrow lies; giving off and diſtributing its nerves to the neck, arms, and legs; and the whole courſe of the canal is rendered ſafe for the marrow, and very ſmooth by lining membranes, the outermoſt of which is of a leather-like ſtrength and thickneſs, and ſerves this double purpoſe; that it is at once a hollow ligament, the whole length of the ſpine upon which the bones are threaded, and by which each individual bone is tied and fixed to the next; and it is alſo a vagina or ſheath which contains the ſpinal marrow, and which is bedewed on its internal ſurface with a thin exudation, keeping the ſheath moiſt and ſoft, and making the encloſed marrow lie eaſy and ſafe.

All down the ſpine, this ſpinal medulla is giving off its nerves: One nerve paſſes from it at the interſtice of each vertebra; ſo that there are twenty-four nerves of the ſpine, or rather forty-eight nerves; twenty-four being given towards each ſide; theſe nerves paſs each through an opening or ſmall hole in the general ſheath; there they paſs through the interſtice of each vertebra; ſo that there is no hole in the bone required, but the nerve eſcapes by going under the articulating proceſs. This, indeed, is converted into ſomething like a hole, when the two contiguous vertebræ are joined to each other.

THE INTERVERTEBRAL SUBSTANCE.—The intervertebral ſubſtance is that which is interpoſed betwixt

betwixt the bodies of two adjoining vertebræ, and which is (at leaſt in the loins) nearly equal in thickneſs to the back of the body of the vertebra to which it belongs. We give it this undefined name, becauſe there is nothing in the human ſyſtem to which it is entirely ſimilar; for it is not ligament, nor is it cartilage, but it is commonly defined to be ſomething of an intermediate nature: It is a ſoft and pliant ſubſtance, which is curiouſly folded and returned upon itſelf, like a rolled bandage with folds, gradually ſofter towards the centre, and with the rolled edges as if cut obliquely into a ſort of convex. The cut edges are thus turned towards the ſurface of the vertebra, to which each intervertebral ſubſtance belongs: it adheres to the face of each vertebra, and it is confined by a ſtrong ligament all round: and this ſubſtance, though it ſtill keeps its hold on each of the two vertebræ to which it belongs, though it permits no true motion of one bone on another, but only by twiſting of its ſubſtance, yields, nevertheleſs, eaſily to which ever ſide we incline, and it returns in a moment to its place by a very powerful reſilience. This perfect elaſticity is the chief character and virtue of this intervertebral ſubſtance, whoſe properties indeed are beſt explained by its uſes; for, in the bendings of the body, it yields in a very conſiderable degree, and riſes on the moment that the weight or the force of the muſcles is removed. In leaping, in ſhocks, or in falls, its elaſticity prevents any harm to the ſpine, while other leſs important joints are luxated and deſtroyed. During the day, it is continually yielding under preſſure; ſo that we are an inch taller in the morning than at night; we are ſhorter in old age than in youth; and the aged ſpine is bended forwards by the yielding of this part. Theſe curious facts were firſt obſerved by ſort of chance, and have ſince been aſcertained with particular care.

Since preſſure, in length of years, ſhortens the fore part of the column of the ſpine, and makes the body ſtoop, any undue inclination to either ſide will cauſe diſtortion: the ſubſtance yields on one ſide, and riſes on the other; and at laſt the ſame change happens in the

the bones alſo, and the diſtortion is fixed, and not to be changed: this is peculiarly apt to happen with children whoſe bones are growing, and whoſe griſtles and intervertebral ſubſtances are peculiarly ſoft; ſo that a tumor on the head or jaw, which makes a boy carry his head on one ſide, or conſtant ſtooping, ſuch as is uſed by a girl in working at the tambour, or the carrying of a weakly child always on one arm by a negligent or awkward nurſe, will cauſe in time a fixed incurable diſtortion.

We are now qualified to underſtand the motions of the vertebræ, and to trace the degree of motion in each individual claſs. The degrees of motion vary with the forms of the vertebræ in each part of the ſpine: the motion is freeſt in the neck, more limited in the loins, and in the back (the middle part of the ſpine) ſcarcely any motion is allowed: the head performs all the nodding motions upon the firſt vertebra of the neck: the firſt vertebra of the neck performs again all the quick and ſhort turnings of the head, by moving upon the dentatus: all the lower vertebræ of the neck are alſo tolerably free, and favour theſe motions by a degree of turning; and all the bendings of the neck are performed by them. The dorſal vertebræ are the moſt limited in their movements, bending chiefly forwards by the yielding of their intervertebral ſubſtance. The vertebræ of the loins again move largely, for their intervertebral ſubſtance is deep, and their proceſſes quite unentangled and free. To perform theſe motions, each vertebra has two diſtinct joints, as different in office as in form: firſt, each vertebra is fixed to thoſe above and below by the intervertebral ſubſtance, which adheres ſo to each, that there is no true motion: there is no turning of any one vertebra upon the next; but the elaſticity of the intervertebral ſubſtance allows the bones to move a little, ſo that there is a general twiſting and gentle bending of the whole ſpine. The ſecond joint is of the common nature with the other joints of the body, for the articulating proceſſes are faced with cartilage, ſurrounded with a capſule, and lubricated with a mucus.

And I conceive this to be the intention of the articulating proceſſes being produced to ſuch a length, that they may lap over each other to prevent luxations of the ſpine; and they muſt, of courſe, have theſe ſmall joints, that they may yield to this general bending of the ſpine.

THORAX.

Of the ribs.—The ribs, whoſe office it is to give form to the thorax, and to cover and defend the lungs, alſo aſſiſt in breathing; for they are joined to the vertebræ by regular hinges, which allow of ſhort motions, and to the ſternum by cartilages, which yield to the motion of the ribs, and return again when the muſcles ceaſe to act.

Each rib, then, is characteriſed by theſe material parts; a great length of bone, at one end of which there is a head for articulation with the vertebræ, and a ſhoulder or knob for articulation with its tranſverſe proceſs; at the other end there is a point, with a ſocket for receiving its cartilage, and a cartilage joined to it, which is implanted into a ſimilar ſocket in the ſide of the ſternum, ſo as to complete the form of the cheſt.

The ribs are twelve in number, according to the number of the vertebræ in the back, of which ſeven are named true ribs, becauſe their cartilages join directly with the ſternum, and five are named falſe ribs, becauſe their cartilages are not ſeparately nor directly implanted into the ſternum but are joined one with another; the cartilage of the lower rib being joined, and loſt in that of the rib above, ſo that all the lower ribs run into one greater cartilage. But there is ſtill another diſtinction, viz. that the laſt rib, and commonly alſo the rib above, is not at all implanted in the ſternum, but is looſely connected only with the muſcles of the abdomen, whence it is named the looſe or floating rib.

The ribs are, in general, of a flattened form, their flat ſides being turned ſmooth towards the lungs. But this flatneſs of the rib is not regular, it is contorted,

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as if the soft rib had been seized by either end, and twisted betwixt the hands: the meaning of which is, to accommodate the flatness of the rib to the form which the thorax assumes in all its degrees of elevation; for when the rib rises, and during its rising through all the degrees of elevation, it still keeps its flat side towards the lungs. Though of a flattened form, the rib is a little rounded at its upper edge, is sharp and cutting at its lower edge; and its lower edge seems double; for there is a groove made there by the intercostal artery and nerve. They are named intercostal, from lying betwixt the ribs, the artery being rather within the rib, is defended in some degree by its groove, the lip of which forms the lower edge of the rib, but still this artery is not without reach of the knife, in some surgical operations; we are careful, therefore, to mark, that it runs on the lower edge of the rib, and is of the size of a crow-quill; and that, if it be wounded, it will bleed largely, from its nearness to the greatest artery of the body; that it is easily shunned, by keeping the knife nearer to the rib below.

On each rib we find the following parts: 1. The HEAD, or round knob by which it is joined to the spine. The head of each rib has indeed but a small articulating surface; but that smooth surface is double, or looks two ways. For the head of the rib is not implanted into the side of one vertebra, it is rather implanted into the interstice betwixt two vertebræ, the head touches both vertebræ; each vertebra bears the mark of two ribs, one above, and one below. The mark of the rib is on the edge of either vertebra, and the socket may be said to lie in the intervertebral substance betwixt them.

2. The NECK of the rib is a smaller part, immediately before the head. Here the rib is particularly small and round.

3. About an inch from the head, there is a second rising, or bump, the articulating surface by which it touches and turns upon the transverse process. These two articulations have each a distinct capsule or bag, each is a very regular joint, and the degree of motions of

of the rib, and direction in which it moves, may be easily calculated, from the manner in which it is jointed with the spine; for the two articulating surfaces of the rib are on its back part; the back of the rib is simply laid upon the side of the spine; the joints with the body of the vertebræ, and with its transverse process, are in one line, and form as if but one joint, so that the rib being fixed obliquely, and at one end only, that end continues firm, except in turning upon its axis; the two heads roll upon the body of the vertebræ, and upon the transverse process; and so its upper end continues fixed, while its lower end rises or falls; and as the motion is in a circle, the head being the central point, moves but little, while the lower end of the rib has the widest range.

4. Just above the second articulating surface, there is a third tubercle, which has nothing to do with the joints, but is intended merely for the attachment of the ligaments and muscles from the spine, which suspend and move the rib.

5. The angle of the rib is often mentioned, being a common mark for the place of surgical operations. There is a flatness of the thorax behind, forming the breadth of the back; the sharpness where this flatness begins to turn into the roundness of the chest is formed by the angles of the ribs. Each rib is round in the place of its head, neck, and tubercles; it grows flatter a little, as it approaches the angle; but it is not completely flattened till it has turned the angle which is the proper boundary betwixt the round and the flat parts of the rib. This anatomy of the ribs is sufficiently simple, but it is not equally easy to observe how it bears on the practice of surgery. It is in some degree useful in the more advanced parts of anatomy, to remember the names, and it is necessary, even in speaking the common language of surgeons, to know these parts, viz. the head of the rib; the tubercle, or second articulating surface; the angle, or turning forward of the rib; the upper round, and the lower flat edge; and especially to remember the place and the dangers of the inter-

intercoſtal artery. It is, however, more important to conſider the connections of parts, as the ſeat of the artery, the manner in which the ribs are lined with the pleura, and their nearneſs to the ſurface of the lungs. There are ſome peculiarities in individual ribs, the chief of which are theſe: the ſize or length of the ribs gradually decreaſes from the firſt to the laſt, the firſt being exceedingly ſhort and circular, the lower ones longer, and almoſt right lined; ſo that the thorax is altogether of a conical ſhape, the upper opening ſo ſmall, as juſt to permit the trachea, œſophagus, and great veſſels to paſs; the lower opening ſo large, that it equals the diameter of the abdomen: the firſt rib is conſequently very ſhort; it is thick, ſtrong, and of a flattened form; of which flatneſs one face looks upwards, and another downwards, and the great axillary artery and vein lie upon its flat upper ſurface. It is alſo particularly circular, making more than half a circle from its head to the extremity where it joins the ſternum; it has, of courſe, no angle, and wants the diſtorted twiſting of the other ribs: the ſecond rib is alſo round, like the firſt rib. The eleventh and twelfth, or the floating ribs, are exceedingly ſmall and delicate, and their cartilage terminates in an acute point, unconnected with the ſternum; and laſtly, the heads of the firſt, and of the eleventh and twelfth ribs, are rounder than any of the others; for theſe three have their heads implanted into the flat ſide of one vertebra only, while all the others have theirs implanted betwixt the bodies of two vertebræ.

The cartilages of the ribs complete the form of the thorax, and form all the lunated edge of that cavity; and it is from this cartilaginous circle that the great muſcle of the diaphragm has its chief origin, forming the partition betwixt the thorax and the abdomen. The farther end of each rib ſwells out thick and ſpongy, and has a ſmall ſocket for lodging the cartilage; for theſe cartilages are not joined like the intervertebral ſubſtances with their bones; but there is a ſort of joint very little moveable indeed, but ſtill having a rude ſocket,

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and a ſtrong capſular ligament, and being capable of luxation by falls and blows ; and the implantations into the ſternum are evidently by fair round ſockets, which are eaſily diſtinguiſhed upon the two edges of that bone. Theſe cartilages may be enumerated thus. The cartilages of the firſt and ſecond ribs deſcend to touch the ſternum. The cartilage of the third rib is direct. The cartilages of the fourth, fifth, and ſixth ribs riſe upwards, in proportion to their diſtance from this central one. The firſt five ribs have independent cartilages ; the eighth, ninth, and tenth ribs run their cartilages into the cartilage of the ſeventh rib ; and the eleventh and twelfth ribs have their cartilages ſmall, unconnected, and floating looſe.

By the motion of the ribs, the thorax is alternately dilated and diminiſhed in capacity, the lungs thereby having their play. A rib has two motions. 1. Its ſternal end riſes and falls, the centre of motion being in the articulation with the ſpine. 2. It moves on its own axis ; a line drawn through the two extremities is the centre of this motion. The former motion enlarges and diminiſhes the diameter of the thorax, from the ſpine to the ſternum, this enlarges the lateral diameter of the thorax.

The sternum.—The ſternum, is that long and ſquared bone, which lies on the fore part of the breaſt over the heart, and which being joined by the cartilages of the ribs, completes the cavity of cheſt ; it is for completing the thorax, and defending the heart, for a medium of attachment to the ribs, and for a fulcrum or point, on which the clavicles may roll.

We find the ſternum conſiſting in the child of eight diſtinct pieces, which run together in the progreſs of life, and which in old age, are firmly united into one ; but in all the middle ſtage of life, we find three pieces in the ſternum, two of which are properly bone, the third remains a cartilage till very late in life, and is named the enſiform cartilage, from its ſword like point.

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It is found to have eight pieces, even in the child of six years old; some years after, it has but five or six; at last but two only; and the salient white lines, which traverse the bone, mark where the intermediate cartilages have once been.

1. The upper piece of the sternum, is very large, roundish, or rather triangular, resembling the form of the heart on playing-cards: it is about two inches in length, and an inch and a half in breadth; and these marks are easily observed. The APEX, or point of the triangle, is pointed downwards, to meet the second bone of the sternum. The BASE OF THE TRIANGLE, which is uppermost, towards the root of the throat seems a little hollowed, for the trachea passing behind it. On each upper corner, it has a large articulating hollow, into which the ends of the collar bones are received; (for this bone is the steady fulcrum upon which they roll). A little lower than this, and upon its side is the socket for receiving the short cartilage of the first rib; and the second rib is implanted in the interstice betwixt the first and second bone of the sternum; so that one half of the socket for its cartilage is found in the lower part of this bone, and the other half, in the upper end of the next.

2. The second piece of the sternum, is of a squared form, very long and flat, and composing the chief length of the sternum; for the first piece receives only the cartilage of the first rib, and one half of the second; but this long piece receives, on each side or edge of it, the cartilages of eight ribs; but as three of the lower cartilages are run into one, there are but five sockets or marks. The sockets for receiving the cartilages of the ribs, are on the edges of the sternum; they are very deep in the firm substance of the bone, and large enough to receive the point of the finger with ease: and whoever compares the size and deepness of these sockets, with the round heads of the cartilages which enter into them, will no more doubt of distinct joints here, than of the distinct articulation of the vertebræ with each other.

 This

3. This is, in truth, the whole of the bony ſternum; and what is reckoned the third piece, is a cartilage merely, and continues ſo, down ſo extreme old age. This cartilage which ekes out, and lengthens the ſternum, and which is pointed like a ſword, is thence named CARTILAGO MUCRONATA, the pointed cartilage, or CARTILAGO ENSIFORMIS, or IXPHOIDES, the ſword-like cartilage. This cartilaginous point extending downwards over the belly, gives a ſure origin and greater power to the muſcles of the abdomen and that without embarraſſing the motions of the body; but this cartilage, which is commonly ſhort and ſingle pointed, is ſometimes forked, ſometimes bent inwards, ſo (it has been thought), as to occaſion ſickneſs and pain; and once was produced to ſuch a length, as to reach the navel, and oſſified at the ſame time, ſo as to hinder the bending of the body, and occaſion much diſtreſs.

The ſternum and the ribs, and all the cheſt ſtand ſo much expoſed, that did we not naturally guard them with the hands, fractures muſt be very frequent, but indeed when they are broken, and beaten in, they hurt the heart or lungs, and not unfrequently the moſt dreadful conſequences enſue. I have already explained that this claſs of bones, defending the moſt noble viſcera (next to the brain), the injuries are almoſt as fatal, as injuries of the brain; often by a wheel paſſing over the body, the ſternum is broken, its pieces preſs inwards upon the heart, which is ſometimes burſt; but more commonly the patients die a ſlow and miſerable death; for the inflammation, which begins in the place of the wound, is extended to the lungs, is propagated ſtill onwards to the heart, and the heart being once inflamed there comes anxiety, oppreſſion, faintings and palpitations; anxious breathing, quick and interrupted pulſe; ſtill more frequent faintings, and then death. The ribs cover more properly the lungs, where the wound or inflammation is not always fatal; for the wound by the point of the rib, is no deeper than juſt to puncture the lungs; but through this ſmall wound on their ſurface, the lungs breathe out their air into the cavity of the cheſt,

cheſt, and at laſt it eſcapes under the cellular ſubſtance of ſkin; the man is blown up to a prodigious degree, with continually encreaſing anxiety, the breathing more and more interrupted, and where he not aſſiſted, he would die.

PELVIS.

To give a ſteady bearing to the trunk, and to connect it with the lower extremities, by a ſure and firm joining, the pelvis is interpoſed, which is a circle of large and firm bones, ſtanding as an arch betwixt the lower extremities and the trunk. Its arch is wide and ſtrong, ſo as to give a firm bearing to the body; its individual bones are large, ſo as to give a deep and ſure ſocket for the implantation of the thigh bone; its motions are free and large, bearing the trunk above and rolling upon the thigh bones below; and it is ſo truly the centre of all the great motions of the body, that when we believe the motion to be in the higher parts of the ſpine, it is either the laſt vertebra of the loins bending upon the top of the pelvis, or the pelvis itſelf rolling upon the head of the thigh bones.

The PELVIS is named partly, perhaps, from its reſembling a baſin in its form; or perhaps, from its office of containing the urinary bladder, rectum, vagina, and womb; it conſiſts, in the child, of many pieces, but in the adult, it is formed of four large bones, of the os ſacrum behind, the oſſa innominata on either ſide, and the os coccygis below.

OS SACRUM, The names os ſacrum, os baſilare, &c. ſeem to relate rather to its greater ſize, than to its ever having been offered in ſacrifice. This bone, with its appendix, the os coccygis, is called the falſe ſpine, or the column of the falſe vertebræ; authors making this diſtinction, that the true vertebræ are thoſe of the back, neck, and loins, a column which grows gradually ſmaller upwards, the falſe vertebræ are thoſe of the ſacrum and coccyx, which are conical, with the apex or point downwards, and the baſe, viz. the top of the ſacrum, turned upwards to meet the true ſpine.

The

The bones of which the facrum is compofed, had originally the form of diftinct fmall vertebræ. Thefe diftinctions are loft in the adult, or are recollected only by the marks of former lines, for the original vertebræ, are now united into one large and firm bone, which is named the column of falfe vertebræ; becaufe, having no motion, it wants the chief character and ufe of the true ones.

We can recognize the original vertebræ, even in the adult bone, for we find it regularly perforated with holes, for the tranfmiffion of the fpinal nerves; we find thefe holes regularly difpofed in pairs; we fee a diftinct white and rifing line which croffes the bone, in the interftice of each of the original vertebræ, and marks the place where the cartilage once was; and by thefe lines being five in number, with five pairs of holes, we know this bone to have confifted once of five pieces. which are now joined into one. The remains of former proceffes can alfo be diftinguifhed, and the back of the bone is rough and irregular from the old fpines.

The os facrum thus compofed, is among the lighteft bones of the human body, with the moft fpongy fubftance, the thinneft tables, the moft eafily broken, and its injuries of the moft formidable nature; but then it is a bone the beft cemented, and confirmed by ftrong ligaments, and the beft covered by thick and cufhion-like mufcles. The os facrum is of a triangular fhape; the bafe of the triangle turned upwards to receive the fpine; its inner furface is fmooth, to permit the head of the child in labour to glide eafily along, and its outer furface is irregular and rough, with the fpines of former vertebræ, giving rife to the great glutæi mufcles, (which form the contour of the hip), and to all the ftrongeft mufcles of the back and loins.

It has in it a triangular cavity under the arch of its fpinous proceffes; which cavity is continued from the canal in the vertebræ of the fpine; and this cavity of the facrum contains the continuation and the end of the fpinal marrow, which being in this place divided into a great many thread-like nerves, has altogether the

the form of a horses tail, and is therefore named cauda equina.

From this triangular cavity, the nerves of the cauda equina go out by the five great holes on the fore part of the sacrum, holes, large enough to receive the point of the finger; the three first nerves of the sacrum, joining with the last nerve of the loins, form the sacrosciatic nerve, the largest in the body, which goes downward to the leg, while the two lower nerves of the sacrum supply the contents of the pelvis alone.

The back of the sacrum is also perforated with holes, whose size is nearly equal to those on its fore part, but whose uses are not so distinctly known; for the small nerves which pass outwards by them to the muscles of the loins or hips, are in no degree proportioned to the size of the holes.

All the edges of this triangle form articulating points, by which it is joined to other bones. The base, or upper part of the sacrum, receives the last vertebra of the loins on a large broad surface, which makes a very moveable joint; and indeed, the joining of the last true vertebra, with the top of the sacrum, is a point where there is more motion than in the higher parts of the spine. The apex or point of the sacrum, has the os coccygis joined to it; which joining, is moveable till the age of twenty in men, and till the age of forty-five in women; and the meaning of its continuing longer moveable in women, is very plain, since we distinctly feel the lower point of the coccyx in women, yielding in the time of labour, so as to enlarge greatly the lower opening of the pelvis. The sides of the os sacrum form a broad, rough, and deeply indented surface, which receives the like rough surface of the haunch bones; and here the surfaces are so rough, and the cartilage so thin, that it resembles more nearly a suture; and by the help of the strong ligaments, and of the large muscles which arise in common from either bone, makes a joining absolutely immoveable, except by such violent force as is in the end fatal.

 Thus

Thus the original ſtate of this bone is eaſily recogniſed and traced by many marks; it ſtands in a conſpicuous place of the pelvis, and its chief office is to ſupport the trunk, to which we may add, that it defends the cauda equina, tranſmits its great nerves, forms chiefly the cavity of the pelvis; and that it is along the hollow of this bone that the accoucheur calculates the progreſs of the child's head in labour.

The os COCCYGIS, ſo named from its reſemblance to the beak of a cuckow, is a ſmall appendage to the point of the ſacrum, terminating this inverted column with an acute point, and found in very different conditions in the ſeveral ſtages of life. In the child it is merely cartilage, and we can find no point of bone; during youth it is oſſifying into diſtinct bones, which continue moveable upon each other, till manhood; then the ſeparate bones gradually unite with each other, ſo as to form one conical bone, with bulgings and marks of the pieces of which it was originally compoſed; but ſtill the laſt bone continues to move upon the joint of the ſacrum, till in advanced years, it is at laſt firmly united, later in women than in men, with whom it is often fixed at twenty or twenty-five. It is not like the os ſacrum, flat, but of a roundiſh form, convex without, and concave inwards, forming with the ſacrum, the loweſt part of the pelvis behind. It has no holes like the ſacrum, has no communication with the ſpinal canal, and tranſmits no nerves, but points forewards to ſupport the lower part of the rectum; thus, it contracts the lower opening of the pelvis, ſo as to ſupport effectually the rectum, bladder, and womb, and yet continues ſo moveable in women, as to recede in time of labour, allowing the head to paſs.

The OSSA INNOMINATA—Are the two great irregular bones, forming the ſides of the pelvis which have a form ſo difficult to explain by one name, that they are called oſſa innominata, the nameleſs bones. But theſe bones having been in the child, formed in diſtinct and ſeparate pieces; theſe pieces retain their original names, though united into one great bone; we continue

to explain them as diſtinct bones, by the names of os ilium, os iſchium, and os pubis. The os ILIUM, the haunch-bone, is that broad and expanded bone on which lie the ſtrong muſcles of the thigh, and which forms the rounding of the haunch. The os ISCHIUM, the hip-bone, the loweſt point of the pelvis, that on which we reſt in ſitting. The os PUBIS, or ſhare-bone, on which the private parts are placed. All theſe bones are divided in the child; they are united in the very centre of the ſocket for the thigh-bone; and we find in the child a thick cartilage in the centre of the ſocket, and a prominent ridge of bone in the adult; which ridge, far from incommoding the articulation with the thigh-bone, gives a firmer hold to the cartilage which lines that cavity, and is the point into which a ſtrong ligament from the head of the thigh-bone is implanted.

The OS ILIUM, or haunch-bone, is named from its forming the flank. It is the largeſt part of the os innominatum. It riſes upwards from the pelvis in a broad expanded wing, which forms the lower part of the cavity of the abdomen, and ſupports the chief weight of the impregnated womb (for the womb commonly inclines to one ſide). The os ilium is covered with the great muſcles that move the thighs, and to its edge are fixed thoſe broad flat muſcles which form the walls of the abdomen. This flat upper part is named the ALA, or WING, while the lower, or rounder part, is named the BODY of the bone, where it enters into the ſocket, and meets the other bones.

The ALA, or flat expanded wing, has many parts which muſt be well remembered, to underſtand the muſcles which ariſe from them. 1. The whole circle of this wing is tipt with a ridge of firmer bone, which encircles the whole. This is a circular cartilage in the child, diſtinct from the bone, and is oſſified and fixed only at riper years. All this ridgy circle is called the ſpine, and is the origin for the lower oblique and tranſverſe muſcles of the abdomen. 2. The two ends of this ſpine are abrupt, and the points formed upon it are conſequently named ſpinous proceſſes, of which there are

two

two at its fore and two at its back end. The two POSTERIOR SPINOUS PROCESSES are cloſe by each other, and are merely two rough projecting points near the rough ſurface, by which the os ilium is joined to the os ſacrum; they jut out behind the articulation, to make it firm and ſure; and their chief uſes ſeem to be the giving a firm hold to the ſtrong ligaments which bind this joint. 3. The two anterior ſpinous proceſſes are more diſtinct, and more important marks for the ANTERIOR SUPERIOR SPINOUS PROCESS, is the abrupt ending of the ſpine, or circle of the ilium, with a ſwelling, out from which jutting point the ſartorius muſcle the longeſt, and amongſt the moſt beautiful in the human body, goes obliquely acroſs the thigh, like a ſtrap, down to the knee; another, which is called the tenſor vaginæ femoris, alſo ariſes here; and from this point departs the ligament, which paſſing from the os ilium to the pubis, or fore point of the pelvis, is called the ligament of the thigh; how neceſſary it is to mark this point, may be eaſily deduced, from knowing that it is under the arch of this femoral ligament that the great artery paſſes down to the thigh, and that the femoral hernia is formed. The LOWER INTERIOR ſpinous proceſs is a ſmall bump, or little ſwelling, about an inch under the firſt one, which gives riſe to the rectus femoris muſcle, or ſtraight muſcles of the thigh, which lies along its fore part.

The back, or DORSUM of the os ilium, is covered with the two great glutæi muſcles; and the COSTÀ, as it is abſurdly called, or the inner concave ſurface, gives riſe to the internal iliac muſcle.

This bone (the os ilium) has a broad rough ſurface, by which it is connected with the os ſacrum at its ſide, the very form of which declares the nature of this joining, and is ſufficient argument and proof that the joinings of the pelvis do not move.

The acute line, which is named LINEA INNOMINATA, is ſeen upon the internal ſurface of the bone, dividing the ala, or wing, from that part which is in the ſocket for the thigh. This line compoſes part of the

brim

brim of the pelvis, diſtinguiſhes the cavity of the pelvis from the cavity of the abdomen, and marks the circle into which the head of the child deſcends at the commencement of labour.

The OS ISCHIUM, or hip-bone, is placed perpendicularly under the os ilium, and is the loweſt point of the pelvis upon which we ſit. It forms the largeſt ſhare of the ſocket, whence the ſocket is named acetabulum iſchii, as peculiarly belonging to this bone. The bump or round ſwelling upon which we reſt, is named the tuber iſchii; and the ſmaller part, which extends upwards to meet the os pubis, is named the ramus, or branch, which meets a ſimilar branch of that bone, to form the thyroid hole.

The BODY is the uppermoſt, and thicker part of the bone, which helps in forming the ſocket; and among the three bones this one forms the largeſt ſhare of it; nearly one half. From the body, a ſharp pointed proceſs, named SPINOUS PROCESS of the iſchium, is projected backwards, which pointing towards the lower end of the ſacrum, receives the uppermoſt of two long ligaments, which, from their paſſing betwixt the iſchium and ſacrum, are named ſacro-ſciatic; by this ligament a ſemi-circle of the os ilium, juſt below the joining of the ilium with the ſacrum, is completed into a large round hole, which is in like manner named the ſacro-ſciatic hole, and gives paſſage to the great nerve of the lower extremity, named the great ſacro-ſciatic nerve.

The TUBER, or round knob, being the point upon which we reſt, this bone has been often named os SEDENTARIUM. The bump is a little flattened where we ſit upon it. It is the mark by which the lithotomiſt directs his inciſion, cutting exactly in the middle betwixt the anus and this point of bone. It is remarkable as the point towards which, the poſterior or lower ſacro-ſciatic ligament extends, and as a point, which gives riſe to ſeveral of the ſtrong muſcles on the back of the thigh, and eſpecially to thoſe which form the hamſtrings.

The

The RAMUS, or branch, riſes obliquely upwards and forwards, to join a like branch of the pubis. This branch, or arm, as it is called, is flat, and its edges are turned a little forewards and backwards, ſo that one edge forms the arch of the pubis, while the other edge forms the margin of the thyroid hole.

The OS PUBIS, or SHARE-BONE, is the laſt and ſmalleſt piece of the os innominatum, and is named from the mons veneris being placed upon it, and its hair being a mark of puberty. It forms the upper, or fore-part of the pelvis, and completes the brim, and, like the iſchium, it alſo is divided into three parts, viz. the BODY, ANGLE, and RAMUS.

The BODY of the pubis is thick and ſtrong, and forms about one-fifth of the ſocket for the thigh-bone. It is not only the ſmalleſt, but the ſhalloweſt part of the ſocket. The bone grows ſmaller, as it advances towards its angle, the joining of the oſſa pubis. There it grows again broad and flat, and the two bones meet with rough ſurfaces, but with two cartilages interpoſed. Over the middle of this bone, two great muſcles, the iliac and pſoas muſcles, paſs out of the pelvis to the thigh; and where they run under the ligament of the thigh, they make the pubis very ſmooth. Along this bone, there is a little edge, or ſharp ridge, which marks the brim of the pelvis, and the part which is over the ſymphyſis, or joining of the bones, riſing higher than the reſt of the ridge, is named the creſt of the pubis; and from this point the ſmall pyramidal muſcles of the abdomen riſe. The RAMUS, or branch, is that more ſlender part of the pubis, which, joining with the branch of the iſchium, forms with it the arch of the pubis, and the edge of the thyroid hole.

This completes the ſtrict anatomy of the pelvis: but when we conſider the whole, it is further neceſſary to repeat, in ſhort definitions, certain points which are oftener mentioned as marks of other parts.

The PROMONTORY of the ſacrum is the projection formed by the loweſt vertebra of the loins, and the

upper point of that bone. The HOLLOW of the ſacrum is all that ſmooth inner ſurface which gives out the great nerves for the legs and pelvis. The LESSER ANGLE, in diſtinction for the greater angle or promontory of the ſacrum, is a ſhort turn in the bone near where it is joined with the os coccygis. The CREST of the PUBIS is a ſharper ridge or edge of the bone over the joining or ſymphyſis pubis. The POSTERIOR SYMPHYSIS of the pelvis is the joining of the ſacrum with the ilium, while the ſymphyſis pubis is diſtinguiſhed by the name of ANTERIOR SYMPHYSIS of the pelvis. The SPINE, the TUBER, and the RAMUS of the iſchium are ſufficiently explained. The ALA, or wing, the SPINE, the SPINOUS PROCESSES, and the LINEA INNOMINATA of the ilium, are alſo ſufficiently explained. The ACETABULUM, ſo named from its reſemblance to a meaſure which the ancients uſed for vinegar, is the hollow or ſocket for the thigh-bone, compoſed of the ilium, iſchium, and pubis; the ridge in its centre ſhows the place of its original cartilage, and points out what proportion belongs to each bone; that it is made, two-fifths by the os ilium, two-fifths by the os iſchium, and one-fifth only by the os pubis: but the iſchium has the greateſt ſhare; the iſchium forming more than two-fifths, and the ilium leſs. The BRIM of the PELVIS is that oval ring which parts the cavity of the pelvis from the cavity of the abdomen: it is formed by a continued and prominent line along the upper part of the ſacrum, the middle of the ilium, and the upper part or creſt of the pubis. This circle of the brim ſupports the impregnated womb, keeps it up againſt the preſſure of the labour-pains; and ſometimes this line has been "as "ſharp as a paperfolder, and has cut acroſs the lower "ſegment of the womb;" and ſo, by ſeparating the womb from the vagina, has rendered the delivery impoſſible; and the child eſcaping into the abdomen among the inteſtines, the woman has died. The OUTLET of the PELVIS is the lower circle again, compoſed by the arch of the pubis, and by the ſciatic ligaments, which is wide and dilatable, to permit the delivery of the

the child, but which being ſometimes too wide, permits the child's head to preſs ſo ſuddenly, and with ſuch violence upon the ſoft parts, that the perineum is torn. The THYROID HOLE is that remarkable vacancy in the bone which perhaps lightens the pelvis, or perhaps allows the ſoft parts to eſcape from the preſſure, during the paſſage of the head of the child.

The marks of the female ſkeleton have been ſought for in the ſkull, as in the continuation of the ſagittal ſuture; but the trueſt marks are thoſe which relate to that great function by which chiefly the ſexes are diſtinguiſhed: for while the male pelvis is large and ſtrong, with a ſmall cavity, narrow openings, and bones of greater ſtrength, the female pelvis is very ſhallow and wide, with a large cavity, and ſlender bones, and with every peculiarity which may conduce to the eaſy paſſage of the child. And this occaſions that peculiar form of the body which the painter is at greater pains to mark, and which is indeed very eaſily perceived: for the characteriſtic of the manly form is firmneſs and ſtrength; the ſhoulders broad, the haunches ſmall, the thighs in a direct line with the body, which gives a firm and graceful ſtep. The female form again is delicate, ſoft, and bending; the ſhoulders are narrow; the haunches broad; the thighs round and large; the knees, of courſe, approach each other, and the ſtep is unſure: the woman, even of the moſt beautiful form, walks with a delicacy and feebleneſs, which we come to acknowledge as a beauty in the weaker ſex.

The bones of the pelvis compoſe a cavity which cannot be fairly underſtood in ſeparate pieces, but which ſhould be explained as a whole. Though perhaps its chief office is ſupporting the ſpine, ſtill its relation to labour deſerves to be obſerved; for this forms at leaſt a curious inquiry, though it ſhould not be allowed a higher place in the order of uſeful ſtudies.

We know, from much experience, that where the pelvis is of the true ſize, we have an eaſy and natural labour: that where the pelvis is too large, there is pain and delay; but not that kind of difficulty which

endangers

endangers life: that where, by diftortion, the pelvis is reduced below the ftandard fize, there comes fuch difficulty as endangers the mother, and deftroys the child, and renders the art of midwifery ftill worthy of ferious ftudy, and an object of public care.

There was a time when it was univerfally believed, that the joinings of the pelvis diffolved in every labour; that the bones departed, and the openings were enlarged; that the child paffed with greater eafe; and "that this "opening of the bafin was no lefs natural than the "opening of the womb." By many accidents, this opinion has been often ftrengthened and revived; and if authority could determine our opinion, we fhould acknowledge, that the joinings of the pelvis were always diffolved as a wife provifion of nature for facilitating natural, and preventing lingering labour, compenfating for the frequent deviations both in the head and pelvis, from their true and natural fize. This unlucky opinion has introduced, at one time, a practice the moft reprehenfibly fimple, as fomentations to foften thefe joinings of the pelvis in circumftances which required very fpeedy help; while, at another time, it has been the apology for the moft cruel unnatural operations of inftruments, not merely intended for dilating and opening the foft parts, but for burfting up thefe joinings of the bones. And thofe alfo, of late years, who have invented and performed (too often, no doubt) this operation of cutting the fymphyfis pubis to haften the labour, fay, that they do not perform an unneceffary cruel operation, but merely imitate a common procefs of nature.

How very far nature is from intending this, may be eafily known from the very forms of thefe joinings, but much more from the other offices which thefe bones have to perform; for if the pelvis be, as I have defined it, an arch ftanding betwixt the trunk and the lower extremities on which the body rolls, its joinings could not part without pain and lamenefs, perhaps inability for life.

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One chief reafon drawn from anatomy, is this: that in women dying after labour, the griftles of the pelvis are manifeftly foftened; the bones loofen; and though they cannot be pulled afunder, they can be fhuffled or moved upon each other in a flight degree: all which is eafily acounted for. The griftle that forms the fymphyfis pubis is not one griftle only, as was once fuppofed, but a peculiar griftle covers the end of each bone, and thefe are joined by a membranous or ligamentous fubftance: this ligamentous fubftance is the part which corrupts the fooneft: it is often fpoiled, and in the place of it a hollow only is found; that hollow of the corrupted ligament may be called a feparation of the bones; but it is fuch a feparation as "equals only the "back of a common knife in breadth, and will not "allow the bones to depart from each other;" the joining is ftill ftrong, for it is furrounded by a capfular ligament, not like the loofe ligament of a moveable joint, but adhering to every point of each bone: and this ligament does perform its office fo completely, that while it remains entire, though the bones fhuffle fideways upon each other, no force can pull them afunder: "Even when the fore part of the pelvis is cut out, and "turned and twifted betwixt the hands, ftill though "the bones can be bent backwards and forwards, they "cannot be pulled from each other the tenth part of "an inch." Thefe inquiries were made by one, who, though partial to the other fide of this queftion, could not allow himfelf to difguife the truth, whofe authority is the higheft, and by whofe facts I fhould moft willingly abide.

Now, it is plain, that fince a feparation, amounting only to the 12th of an inch, occafions death, this cannot be a provifion of nature; and fince the feparation in fuch degree could not enlarge the openings of the bafin, there again it cannot be a provifion of nature. I know that tales are not wanting of women whofe bones were feparated during labour; but what is there fo abfurd, that we fhall not find a precedent or parallel cafe

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in our annals of monſtrous and incredible facts? Or rather where is there a fact of this deſcription which is not balanced and opoſed by oppoſite authorities and facts. I have diſſected ſeveral women who had died in lingering labour, where I found no diſunion of the bones. I have ſeen women opened, after the greateſt violence with inſtruments, and yet found no ſeparation of the bones. We have caſes of women having the mollities oſſium, a univerſal ſoftneſs, and bending of the bones, who have lived in this condition for many years, with the pelvis alſo affected; its openings gradually more and more abridged; the miſerable woman ſuffering lingering labour, and undergoing the delivery by hooks, with all the violence that muſt be uſed in ſuch deſperate caſes, and ſtill no ſeparation of the bones happening. How, indeed, ſhould there be ſuch difficult labours as theſe, if the ſeparation of the bones could allow the child to paſs?

If it be ſaid, "the joinings of the pelvis are ſome-"times diſſolved," I acknowledge, that they are juſt as the joint of the thigh is diſſolved, that is, ſometimes by violence, and ſometimes by internal diſeaſe; but if it be affirmed, that "the joinings of the pelvis are diſ-"ſolved to facilitate labour," I would obſerve, that wherever ſeparation of the bones has happened, it has both increaſed the difficulties of the labour, and been in itſelf a verry terrible diſeaſe; for proofs of which, I muſt refer to Hunter, Denman, and others, to whoſe peculiar province ſuch caſes belong. But ſurely theſe principles will be univerſally acknowledged: that the pelvis ſupporting the trunk, is the centre of its largeſt motions: that if the bones of the pelvis were looſened, ſuch motions could no longer be performed: that when, by violence or by internal diſeaſe, or in the time of ſe-vere labour, theſe joinings have actually been diſſolved or burſt, the woman has become inſtantly lame, unable to ſit, ſtand, or lie, or ſupport herſelf in any degree; ſhe is rendered incapable of turning, or even of being turned in bed; her attendants cannot even move her legs

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without intolerable anguifh, as if torn afunder *: there fometimes follows a collection of matter within the joint (the matter extending quite down to the tuber ifchii), high fever, delirium, and death †; or, in cafe of recovery (which is indeed more frequent), the recovery is flow and partial only; a degree of lamenefs remains, with pain, weaknefs, and languid health; they can ftand on one leg more eafily than on both; they can walk more eafily than they can ftand; but it is many months before they can walk without crutches; and long after they come to walk upon even ground, climbing a ftair continues to be very difficult and painful. In order to obtain even this flow re-union of the bones, the pelvis muft be bound up with a circular bandage very tight; and they muft fubmit to be confined long: by neglect of which precautions, fometimes, by the rubbing of the bones, a preternatural joint is formed, and they continue lame for years, or for life ‡; or fometimes the bones are united by offification; the callus or new bone projects towards the centre of the pelvis, and makes it impoffible for the woman to be delivered again of a living child §.

Now this hiftory of the difeafe leads to reafons independent of anatomy, and furer than it; which prove, that this feparation of the bones (an accident the exiftence of which cannot be queftioned), is not a provifion of nature, but is a moft ferious difeafe. For if thefe be the dreadful confequences of feparation of the bones, how can we b. lieve that it happens, when we fee women walking during all their labour, and, in place of being pained, are rather relieved by a variety of poftures, and by walking about their room? who often walk to bed after being delivered on chairs or couches? who rife on the third day, and often refume the care and fatigues of a family in a few days more? or can we believe, that there is a tendency to feparation of the

* Denman. † Hunter.

‡ Denman fays twenty-five or thirty years.

§ Spence's cafes.

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bones in thofe who, following the camp, are delivered on one day, and walk on the following? or in thofe women who, to conceal their fhame, have not indulged in bed a fingle hour? or can we believe, that there is even the flighteft tendency to the feparation of the bones in thofe women whofe pelvis refifts the force of a lingering and fevere labour, who fuffer ftill further all the violence of inftruments, who yet recover as from a natural delivery, and who alfo rife from bed on the third or fourth day?

CHAP. VI.

BONES OF THE THIGH, LEG, AND FOOT.

THE THIGH BONE is the greateft bone of the body, and needs to be fo, fupporting alone, and in the moft unfavourable direction, the whole weight of the trunk; for though the body of this bone is in a line with the trunk, in the axis of the body, its neck ftands off almoft at right angles with the body of the bone; and in this ufavourable direction muft it carry the whole weight of the trunk, for the body is feldom fo placed as to reft its weight equally upon either thigh bone; commonly it is fo inclined from fide to fide alternately, that the neck of one thigh bone bears alone the whole weight of the body and limbs, or is ftill loaded with greater burdens than the mere weight of the body itfelf.

The thigh bone is one of the moft regular of the cylindrical bones. 1. Its BODY is very thick and ftrong, of a rounded form, fwelling out at either end into two heads. In its middle it bends a little outwards, with its circle or convex fide turned towards the fore part of the thigh. This bending of the thigh bone has been a fubject of fpeculation abundantly ridiculous, viz. whether this be an accidental or a natural arch. There are authors who have afcribed it to the nurfe carrying the child by the thighs, and its foft bones bending under the weight. There is another author,

very juftly celebrated, who imputes it to the weight of the body, and the ftronger action of the flexor mufcles, affirming, that it is ftraight in the child, and grows convex by age. This could not be, elfe we fhould find this curve lefs in fome, and greateft in thofe who had walked moft, or whofe mufcles had the greateft ftrength; and if the mufcles did produce this curve, a little accident giving the balance to the flexor mufcles, fhould put the thigh bone in their power to bend it in any degree, and to caufe diftortion. But the end of all fuch fpeculations is this, that we find it bended in the fœtus, not yet delivered from the mother's womb, or in a chicken, while ftill enclofed in the fhell; it is a uniform and regular bending, defigned and marked in the very firft formation of the bone, and intended, perhaps, for the advantage of the ftrong mufcles in the back of the thigh, to give them greater power, or more room.

2. The HEAD of the thigh bone is likewife the moft perfect of any in the human body, for its circumference is a very regular circle, of which the head contains nearly two-thirds: it is fmall, neat, and completely received into its focket, which is not only deep in itfelf, and very fecure, but is further deepened by the cartilage which borders it, fo that this is naturally, and without the help of ligaments, the ftrongeft joint in all the body; but among other fecurities which are fuperadded, is the round ligament, the mark of which is eafily feen, being a broad dimple in the centre of its head.

3. The NECK of this bone is the trueft in the fkeleton; and indeed it is from this neck of the thigh bone that we transfer the name to other bones, which have hardly any other mark of neck than that which is made by their purfe-like ligament being fixed behind the head of the bone, and leaving a roughnefs there. But the neck of the thigh bone is an inch and a half in length, thick and ftrong, yet hardly proportioned to the great weights which it has to bear; long, that it may allow the head to be fet deeper in its focket; and ftanding wide up from the fhoulders of the bone, to

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keep its motions wide and free, and unembarraſſed by the pelvis; for without this great length of the neck, its motions had been checked even by the edges of its own ſocket.

The TROCHANTERS are the longeſt proceſſes in the human body for the attachment of muſcles, and they are named trochanter (or proceſſes for turning the thigh), from their office, which is the receiving thoſe great muſcles which not only bend and extend the thigh, but turn it upon its axis; for theſe proceſſes are oblique, ſo as to bend and turn the thigh at once.

4. The TROCHANTER MAJOR, the outermoſt and longer of the two, is that great bump which repreſents the direct end of the thigh-bone, while the neck ſtands off from it at one ſide; therefore the great trochanter ſtands above the neck, and is eaſily diſtinguiſhed outwardly, being that great bump which we feel ſo plainly in laying the hand upon the haunch. This proceſs receives the glutæi muſcles, and all the great muſcles which move the thigh outwards.

5. The TROCHANTER MINOR, or leſſer trochanter, is a ſmaller and more pointed riſing on the inner ſide of the bone, lower than the trochanter major, and placed under the root of the neck, as the greater one is placed above it. It is deeper in the thigh, and never to be felt, not even in luxations. Its muſcles alſo, by the obliquity of their inſertion into it, turn the thigh, and bend it towards the body, ſuch as the pſoas and iliacus internus, which paſſing out from the pelvis, ſink deep into the groin, and are implanted into this point. From the one trochanter to the other, there is a very conſpicuous roughneſs, which marks the place of the capſule, or ligamentary bag of the joint; for it encloſes the whole length of the neck, and of the thigh bone. This roughneſs begins the great rough line, and is what is regularly named linea aſpera.

6. Betwixt the greater and leſſer trochanters, there runs a rough line, the *inter trochantral line.*

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7. The LINEA ASPERA is a riſing or prominent line, very ragged and unequal, which runs all down the back part of the thigh: it begins at the roots of the two trochanters, and the rough lines from each trochanter meet about four inches down the bone; thence the linea aſpera runs down the back of the bone a ſingle line, and forks again into two lines, one going towards each condyle, and ending in the tubercles at the lower end of the bone, ſo that the linea aſpera is ſingle in the middle, and forked at either end.

8. The CONDYLES are the two tubers into which the thigh-bone ſwells out at its lower part. There is firſt a gentle and gradual ſwelling of the bone, then an enlargement into two broad and flat ſurfaces, which are to unite with the next bone in forming the great joint of the knee. The two tuberoſities, which, by their flat faces, form the joint, ſwell out above the joint, and are called the CONDYLES. The INNER CONDYLE is larger, to compenſate for the oblique poſition of the thigh bone; for the bones are ſeparated at their heads, by the whole width of the pelvis, but are drawn towards a point below, ſo as to touch each other at the knees. On the fore part of the bone, betwixt the condyles, there is a broad ſmooth ſurface, upon which the rotula, or pully-like bone glides; and on the back part of the thigh-bone, in the middle betwixt the condyles, there is a deep notch, which contains the great artery, vein and nerve of the leg.

The great nutritious artery enters below the middle of this bone, and ſmaller arteries enter through its porous extremities; as may be known by many ſmall holes, near the head of the bone.

The HEAD of the thigh bone is round, and ſet down deeply in its ſocket, to give greater ſecurity to a joint ſo important, and ſo much expoſed as the hip is. The NECK ſtands off from the reſt of the bone, ſo that by its length, it allows a free play to the joint, but is itſelf much expoſed by its tranſverſe poſition, as if nature had not formed in the human body, any joint at once

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free, moving and ſtrong. The neck is not formed in the boy, becauſe the ſocket is not yet deep, nor hinders the motions of the thigh, and the head is formed apart from the bone, and is not firmly united with it, till adult years, ſo that falls luxate, or ſeparate the head in young people, but they break the neck of the bone, in thoſe that are advanced in years. The TROCHANTERS, or ſhoulders, are large, to receive the great muſcles which are implanted in them, and oblique, that they may at once bend and turn the thigh. The SHAFT or BODY is very ſtrong, that it may bear our whole weight, and the action of ſuch powerful muſcles; and it is marked with the rough line behind, from which a maſs of fleſh takes its riſe, which wraps completely round the lower part of the thigh bone, and forms what are called the vaſti muſcles, the greateſt muſcles for extending the leg. The CONDYLES ſwell out to give a broad ſurface, and a firm joining for the knee. But of all its parts, the great trochanter, ſhould be moſt particularly obſerved, as it is the chief mark in luxations or fractures of this bone: for when the greater trochanter is puſhed downwards, we find the thigh luxated inward; when the trochanter is higher than its true place, and ſo fixed that it cannot roll, we are aſſured that it is luxated; but when the trochanter is upwards, with the thigh rolling freely, we are aſſured its neck is broken, the trochanter being diſplaced, and the broken head remaining in its ſocket; but when the trochanter remains in its place, we ſhould conclude that the joint is but little injured, or that it is only a bruiſe of thoſe glands or mucous follicles, which are lodged within the ſocket, for lubricating the joint.

The TIBIA is named from its reſemblance to a pipe; the upper part of the tibia, repreſenting the expanding or trumpet-like end, the lower part repreſenting the flute end of the pipe. The tibia, on its upper end, is flat and broad, making a moſt ſingular articulation with the thigh-bone; for it is not a ball and ſocket like the ſhoulder

ſhoulder or hip, nor a hinge joint guarded on either ſide with projecting points, like the ancle. There is no ſecurity for the knee joint, by the form of its bones, for they have plain flat heads; they are broad indeed, but they are merely laid upon each other. It is only by its ligaments that this joint is ſtrong; and by the number of its ligaments it is a complex and delicate joint, peculiarly liable to diſeaſe.

1. The UPPER HEAD of the tibia, is thick and ſpongy, and we find there, two broad and ſuperficial hollows, as if impreſſed while ſoft, with the marks of the condyles of the thigh bone; and theſe ſlight hollows, are all the cavity that it has for receiving the thigh-bone. A pretty high ridge riſes betwixt theſe two hollows, ſo as to be received into the interſtice betwixt the condyles, and to the back part, which is the higheſt point of the ridge; an internal ligament ties the tibia to the thigh-bone. The ſpongy head has alſo a rough margin, to which the capſular ligament is tied; on the fore part of this bone, juſt below the knee, there is a bump for receiving the great ligament of the patella, or in other words, the great tendon of of all the extenſor muſcles of the leg; and laſtly, there is upon the outer ſide of this ſpongy head, juſt under the margin of the joint, a ſmooth articulating ſurface, (like a dimple impreſſed with the finger), for receiving the head of the fibula. It is under the margin of the joint, for the fibula does not enter at all into the knee joint; it is only laid upon the ſide of the tibia, fixed to it by ligaments, but not received into any thing like a cavity.

2. The BODY of the bone is of a priſmatic or triangular form, and its three edges or acute angles are very high lines running along its whole length; one line a little waved, and turned directly forwards, is what is called the ſhin. At the top of this ridge, is that bump into which the ligament of the rotula or patella is implanted; and the whole length of this acute line is ſo eaſily traced through the ſkin, that we can never be miſtaken about fractures of this bone. Another line

leſs acute than this, is turned directly backwards; and the third acute line, which completes the triangular form, is turned towards the fibula, to receive a broad ligament, or interoſſeous membrane, which ties the two bones together.

3. The lower head of the tibia compoſes the chief parts of the ancle joint. The lower head of the tibia is ſmaller than the upper, in the ſame proportion, that the ancle is ſmaller than the knee. The pointed part of this head of the tibia repreſents the mouth piece, or flat part of the pipe, and conſtitutes the bump of the INNER ANCLE. The lower end of the fibula lies ſo upon the lower end of the tibia, as to form the outer ancle; and there is on the ſide of the tibia, a deep hollow, like an impreſſion made with the point of the thumb, which receives the lower end of the tibula. The acute point of the tibia, named the proceſs of the inner ancle, paſſes beyond the bone of the foot, and, by lying upon the ſide of the joint, guards the ancle, ſo that it cannot be luxated outward, without this pointed proceſs of the maleolus internus, or inner ancle, being broken.

4. On the back part of the tibia, and a little below its head, we have to obſerve the hole for the tranſmiſſion of the nutritious artery, to the centre of the bone. In amputation of the leg, this artery is ſometimes cut acroſs juſt where it has entered the bone, and the bleeding proves troubleſome.

The tibia is a bone of great ſize, and needs to be ſo, for it ſupports the whole weight of the body. It is not at all aſſiſted by the fibula, in bearing the weight, the fibula, or ſlender bone, being merely laid upon the ſide of the tibia, for uſes which ſhall be explained preſently. The tibia is thick, with much cancelli, or ſpongy ſubſtance within; has pretty firm plates without; is much ſtrengthened by its ridges, and by its triangular form: its ridges are regular with regard to each other, but the whole bone is twiſted as if it had been turned betwixt the hands when ſoft: This diſtortion makes the proceſs of the inner ancle lie not regu-

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larly upon the ſide of that joint, but a little obliquely forward, which determining the obliquity of the foot, which muſt be of much conſequence, ſince there are many proviſions for ſecuring this turning of the foot, viz. the oblique poſition of the trochanters; the oblique inſertion of all the muſcles, and this obliquity of the ancles; the inner ancle, advancing a little before the joint, and the outer ancle receding in the ſame degree behind it.

The FIBULA, which is named ſo from its reſemblance to the Roman claſp, is a long ſlender bone, which is uſeful partly in ſtrengthening the leg, but chiefly in forming the ancle joint; for the tibia only is connected with the knee, while the fibula, which has no place in the knee joint, goes down below the lower end of the tibia, forming the long proceſs of the outer ancle.

The fibula is a long and ſlender bone, the longeſt and ſlendereſt in the body. It lies by the ſide of the tibia like a ſplint, ſo that when at any time the tibia is broken without the fibula, or when the tibia having ſpoiled, becomes carious, and a piece of it is loſt, the fibula maintains the form of the limb till the laſt piece be replaced, or till the fracture be firmly reunited. It is like the tibia, triangular in the middle part, but ſquare towards the lower end, and has two heads, which are knots, very large, and diſproportioned to ſo ſlender a bone. The ſharpeſt line of the fibula is turned to one ſharp line of the tibia, and the interoſſeous membrane paſſes betwixt them. The bone lies in a line with the tibia, on the outer ſide of it, and a little behind it. The upper head of the fibula is rough on the outer ſurface, for the inſertion of the *biceps cruris*, ſmooth and light, with cartilage within, and is laid upon a plain ſmooth ſurface, on the ſide of the tibia, a little below the knee; and though the fibula is not received deep into the tibia, this want is compenſated for by the ſtrong ligaments by which this little joint is tied by the knee, being completely wrapped round with the expanded tendons of thoſe great muſcles which make

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up the thigh, by the knee being ſtill farther embraced cloſely by the faſcia, or tendinous expanſion of the thigh; but above all, by the tendons of the outer hamſtrings being fixed into this knot of the fibula, and expanding from that over the fore part of the tibia.

The lower head of the fibula is let pretty deep into a ſocket on the ſide of the tibia; together, they form the ancle joint for receiving the bones of the foot. The ancle joint is one of the pureſt hinge joints, and is very ſecure; for there is the tibia, at the proceſs of the inner ancle, guarding the joint within, there is the fibula paſſing the joint ſtill further, and making the outer ancle ſtill a ſtronger guard without. Theſe two points, projecting ſo as to encloſe the bones of the foot, making a pure hinge; prevent all lateral motion; make the joint firm and ſtrong, and will not allow of luxations, till one or both ancles be broken. We know that there is little motion betwixt the tibia and fibula; none that is ſenſible outwardly, and no more in truth than juſt to give a ſort of elaſticity, yielding to ſlighter ſtrains. But we are well aſſured, that this motion, though ſlighteſt and imperceptible, is very conſtant; for theſe jointing of the fibula with the tibia are always found ſmooth and lubricated; and there are no two bones in the body ſo cloſely connected as the tibia and fibula are, which are not ſo ſeldom anchyloſed, (i. e.) joined into one by diſeaſe.

The fibula may be thus defined: it is a long ſlender bone, which anſwers to the double bone of the fore arm, completes the form, and adds ſomewhat to the ſtrength of the leg; it gives a broader origin for its ſtrong muſcles, lies by the ſide of the tibia like a ſplint; and, being a little arched towards the tibia, ſupports it againſt thoſe accidents which would break it acroſs, and maintains the form of the leg when the tibia is carious or broken; the fibula, though it has little connection with the knee, paſſes beyond the ancle joint, and is its chief guard and ſtrength in that direction in which the joint ſhould be moſt apt to yield; and

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in this office of guarding the ancle, it is ſo true, that the ancle cannot yield till this guard of the fibula be broken.

ROTULA OF PATELLA, OF KNEE-PAN, is a ſmall thick bone, of an oval, or rather triangular form. The baſis of this rounded triangle is turned upwards to receive the four great muſcles which extend the leg; the pointed part of this triangle is turned downwards, and is tied by a very ſtrong ligament to the bump or tubercle of the tibia, juſt under the knee. This ligament is called the ligament of the patella, or of the tibia, connecting the patella ſo cloſely, that ſome anatomiſts of the firſt name chooſe to ſpeak of the patella as a mere proceſs of the tibia, (as the olecranon is a proceſs of the ulna), only flexible and looſe; an arrangement which I think ſo far right and uſeful, as the fractures of the olecranon and of the patella are ſo much alike, eſpecially in the method of cure, that they may be ſpoken of as one caſe; for theſe two are the only exceptions to the common rules and methods of ſetting broken bones.

The patella is manifeſtly uſeful, chiefly as a lever; for it is a pully, which is a ſpecies of lever, gliding upon the fore part of the thigh bone, upon the ſmooth ſurface which is betwixt the condyles. The projection of this bone upon the knee removes the acting force from the centre of motion, ſo as to increaſe the power; and it is beautifully contrived, that while the knee is bent, and the muſcles at reſt, as in ſitting, the patella ſinks down, concealed into a hollow of the knee. When the muſcles begin to act, the patella begins to riſe from this hollow; in proportion as they contract, they loſe of their ſtrength, but the patella gradually riſing, increaſes the power; and when the contraction is nearly perfect, the patella has riſen to the ſummit of the knee, ſo that the riſing of the patella raiſes the mechanical power of the joint in exact proportion as the contraction expends the living contractible power of the muſcles. What is curious beyond almoſt any other fact concerning the fractures of bones, the patella

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is ſeldom broken by a fall or blow; in nine of ten caſes, it is rather torn, if we may uſe the expreſſion, by the force of its own muſcles, while it ſtands upon the top of the knee, ſo as to reſt upon one ſingle point; for while the knee is half bended, and the patella in this dangerous ſituation, the leg fixed, and the muſcles contracting ſtrongly to ſupport the weight of the body, or to raiſe it as in mounting the ſteps of a ſtair, the force of the muſcles is equivalent at leaſt to the weight of the man's body; and often, by a ſudden violent exertion, their power is ſo much increaſed, that they ſnap the patella acroſs, as we would break a ſtick acroſs the knee.

The TARSUS, or INSTEP, is compoſed of ſeven large bones, which form a firm and elaſtic arch for ſupporting the body; which arch has its ſtrength from the ſtrong ligaments with which theſe bones are joined, and its elaſticity from the ſmall movements of theſe bones with each other; for each bone and each joint has its cartilage, its capſule or bag, its lubricating fluid, and all the apparatus of a regular joint; each moves, ſince the cartilages are always lubricated, and the bones are never joined by anchyloſis with each other; but the effect is rather a diffuſed elaſticity, than a marked and perceptible motion in any one joint.

The ſeven bones of which the tarſus is compoſed are, 1. The ASTRAGALUS, which, united with the tibia and fibula, forms the ancle joint. 2. The OS CALCIS, or heel-bone, which forms the end or back point of that arch upon which the body ſtands. 3. The OS NAVICULARE, or boat-like bone, which joins three ſmaller bones of the fore part of the tarſus to the aſtragalus. 4. The OS CUBOIDES, which joins the ſmaller bones of the fore part to the os calcis. The 5th, 6th, and 7th, are the ſmaller bones making the fore part of the tarſus; they lie immediately under the place of the ſhoe-buckle, and are named the three CUNEIFORM BONES, from their wedge-like ſhape; and it is upon theſe that the metatarſal bones, forming the next diviſion of the foot, are implanted.

These bones of the tarsus form, along with the next rank, or metatarsal bones, a double arch; first from the lowest point of the heel to the ball of the great toe, is one arch; the arch of the sole of the foot, which supports the body; and again, there is another arch within this, formed among the tarsal bones themselves, one within another, *i. e.* betwixt the astragalus calcis, and naviculare, through which hole, in my drawing, there is passed a pencil. It is this second arch which gives a perfect elasticity to the foot, and must prevent the bad effects of leaping, falls, and other shocks, which would have broken a part less curiously adapted to its office.

1. The ASTRAGALUS is the greatest and most remarkable bone of the tarsus, and which the surgeon is most concerned in knowing. The semi-circular head of this bone forms a curious and perfect pully. The circle of this pully is large; its cartilage is smooth and lubricated; it is received deep betwixt the tibia and fibula, and rolls under the smooth articular surface of the latter, which being suited to this pully of the astragalus, with something of a boat-like shape, is often named the scaphoid cavity of the tibia. 1. We remark in the astragalus its articulating surface, which is arched, high, smooth, covered with cartilage, lubricated, and in all respects a complete joint. Its form is that of a pully, which, of course, admits of but one direct motion, viz. forwards and backwards. 2. We observe its sides, which are plain, smooth, and flat, covered with the same cartilage, forming a part of the joint, and closely locked in by the inner and outer ancles, so as to prevent luxations, or awkward motions to either side. 3. We observe two large irregular articulating surfaces backwards, by which it is joined to the os calcis. 4. There is on the fore part, or rather the fore end of the astragalus, a large round head, as regular as the head of the shoulder bone, by which it is articulated with the scaphoid bone.

2. The OS CALCIS is the large irregular bone of the heel;

heel; it is the tip or end of the arch formed by the tarſal and metatarſal bones. There is a large ſcabrous point on which we ſtand, which is rough, for the inſertion of the great Achillis tendon, the rope by which the muſcles of the calf act. The roughneſs of the heel bone gives the tendon a firm hold, and its projection backwards gives it the power of a very long lever. The points to be obſerved are, 1. The great backward projection, which is properly called the heel, ſcabrous and rough, for the inſertion of the great achillis tendon, and the point upon which we walk and ſtand. 2. An irregular articular ſurface, or rather two ſurfaces covered with cartilage, by which it is joined with the aſtragalus. 3. Another articulating ſurface by which it is joined with the os cuboides. And, 4. A ſort of arch downwards, under which the veſſels and nerves and the tendons alſo paſs on ſafely into the ſole of the foot.

3. The next bone is named os NAVICULARE, or os SCAPHOIDES, from a fanciful reſemblance to a boat. But this is a name of which anatomiſts have been peculiarly fond, and which they have uſed with very little diſcretion or reſerve: the ſtudent will hardly find any ſuch reſemblance: it is rather like the dies with which we play at drafts; that is, a flattened circular body, with its borders riſing up a little; and each flat ſide forms an articulating ſurface. That concave ſide which looks backwards, is pretty deep, and receives the head of the aſtragalus: that flat ſide which looks forwards, has not ſo deep a ſocket, but receives the three cuneiform bones upon a ſurface rather plain and irregular.

The CUNEIFORM BONES are ſo named, becauſe they reſemble wedges, being laid to each other like the ſtones of an arch. The moſt ſimple and proper arrangement is, 1. 2. and 3.; counting from the ſide of the great toe towards the middle of the foot; but they are commonly named thus: the firſt cuneiform bone, on which the great toe ſtands, has its cutting edge turned upwards; it is much larger than the others, and ſo is

 called

called OS CUNEIFORM MAGNUM. The ſecond cuneiform bone, or that which ſtands in the middle of the three cuneiform bones, is much ſmaller, and is therefore named OS CUNEIFORM MINIMUM. The third, in order, of the cuneiform bones, is named OS CUNEIFORM MEDIUM *. Theſe cuneiform bones receive the great toe and the two next to it. The fourth and fifth toes are implanted upon the laſt bone in the row, the os cuboides.

OS CUBOIDES.—The os cuboides is named from its cubical figure, and is next to the aſtragalus in ſize, greater than the ſcaphoid bone. The three cuneiform bones are laid regularly by the ſide of each other; and this os cuboides is again laid on the outer ſide of the third cuneiform bone, and joins it to the os calcis. The place and effect of the cuboid bone is very curious; for as it is jammed in betwixt the third cuneiform bone and the os calcis, it forms a complete arch within an arch, which gives at once a degree of elaſticity and of ſtrength which no human contrivance could have equalled. There is firſt a great arch on which the body reſts, and the heel and the great toe are the horns of that bow: and, ſecondly, there is a complete circle among the metatarſal bones, leaving an opening betwixt the aſtragalus and the os calcis.

THE TOES.—The laſt diviſion of the foot conſiſts of three diſtinct bones; and as theſe bones are diſpoſed in rows, they are named the firſt, ſecond, and third phalanges or ranks of the toes.

The great toe has but two phalanges; the other toes have three ranks of bones, which have nothing particular,

* The confuſion in theſe names ariſes from ſometimes counting them by their place, and ſometimes reckoning according to their ſize. It is only in relation to its ſize that we call one of theſe bones os cuneiform medium; for the os cuneiform medium is not in the middle of the three; it is the middle bone with reſpect to ſize: it is the ſmalleſt of cuneiform bones that ſtands in the middle betwixt the other two.

ticular, only the joints are round and free, formed by a round head on one bone, and by a pretty deep hollow, for receiving it in the one above it; they are a little flattened on their lower fide, or rather they have a flattened groove which lodges the tendons of the laft joint of the toes.

The SESAMOID BONES are more regularly found about the toes than any where elfe. They are fmall bones, like peas, found in tendons, at any point where they fuffer much friction; or rather they are like the feeds of the fefamum, whence their name. They are found chiefly at the roots of the great toe, and of the thumb; at each of thefe places we find two fmall fefamoid bones, one on each fide of the ball of the great toe, and one on each fide of the ball of the thumb; but thefe bones do not enter into the joint; they are within the fubftance of the tendons; perhaps, like the patella, they remove the acting force from the centre of motion, and fo, by acting like pullies, they increafe the power; perhaps alfo by lying at the fides of the joint in the tendons of the fhorter mufcles of the toes, they make a fafe gutter for the long tendons to pafs in. They are not reftricted to the balls of the great toe and thumb, but fometimes are alfo found under the othertoes and fingers, and fometimes behind the condyles of the knee; or in the peronæi tendons, which run underthe fole of the foot. In fhort, they are fo far from being regular bones, that they are found only in adults, and are fo often found in irregular places, that they almoft feem to be produced by chance, or by the effect of friction.

METATARSUS.—The metatarfus is fo named from its being placed upon the tarfus; confifts of five bones, which differ fo little from the firft bones of the fingers, that they need not be minutely demonftrated. It is fufficient to mark, that they are five in number, having a general refemblance to the joints of the finger; that they are rather flattened, efpecially on their lower fides, where the tendons of the toes lie; that they are very large at their ends next the tarfus, where they have broad flat heads, that they may be im-

 planted

planted with great ſecurity; that they grow ſmaller towards the toes, where again they terminate, in neat ſmall round heads, which receive the firſt bones of the toes, and permit of a very free and eaſy motion, and a greater degree of rotation than our dreſs allows us to avail ourſelves of, the toes being cramped together, in a degree that fixes them all in their places, huddles one above another, and is quite the reverſe of that free and ſtrong like ſpreading of the toes, which the painter always repreſents. Laſtly, it ſhould be remarked, that the metatarſal bone of the little toe, makes a ſalient angle, projecting over the tarſus, in a point which is eaſily felt outwardly, at the place where the ſide ſeam of the ſhoe croſſes: for this, and all the other marks of the metatarſal bones, are chiefly uſeful as directing us where to cut in amputating theſe bones; and the ſurgeon will ſave the patient much pain, and himſelf the ſhame of a ſlow and confuſed operation, by marking the places of the joints.

CHAP. VII.

BONES OF THE SHOULDER, ARM, AND HAND.

OF THE SCAPULA, OR SHOULDER BLADE.

This is the great peculiarity of the ſuperior extremity, that it is connected not directly with the trunk, like the thigh bone with the haunch, but is hung by a moveable intermediate bone, which not only is not immediately joined to the trunk by ligaments, nor any other form of connection, but is parted from it by ſeveral layers of muſcular fleſh, ſo that it lies flat, and glides upon the trunk.

The SCAPULA is a thin bône, which has originally, like the ſkull, two tables, and an intermediate diploe; but by preſſure, and the action of its own muſcles, it grows gradually thinner, its tables are more and more condenſed, till in old age it has become perfectly tranſparent,

parent, and is ſupported only by its proceſſes, and by its thicker edges; for its SPINE is a ridge of firm and ſtrong bone, which riſes very high, and gives a broad origin and ſupport for its muſcles. The ACROMION in which the ſpine terminates, is a broad and flat proceſs, a ſure guard for the joint of the ſhoulder. The CORACOID proceſs is a ſtrong but ſhorter proceſs, which ſtands out from the neck of the bone; and the COSTA, or borders of the bone are alſo rounded firm and ſtrong, ſo that the proceſſes and borders ſupport the flat part of the bone, which is as thin as a ſheet of paper, and quite tranſparent.

There is no part nor proceſs of the ſcapula which does not require to be very carefully marked; for no accidents are more frequent than luxations of the ſhoulder; and the various luxations are explained beſt by ſtudying in the ſkeleton, and being able to recognize on the living body all the proceſſes and projecting points.

1. The FLAT SIDE of the ſcapula is ſmooth, ſomewhat concave, and ſuited to the convexity of the ribs. The ſcapula is connected with no bone of the trunk, tied by no ligaments, is merely laid upon the cheſt, with a large maſs of muſcular fleſh under it, upon which it glides; for there are below it two layers of muſcles, by one of which the ſhoulder bone is moved upon the ſcapula, while by the other, the ſcapula itſelf is moved upon the ribs. The muſcle, lying in the hollow of the ſcapula, marks it with many ſmooth hollows, and wave-like riſings, which are merely the marks of the origin of its muſcles, but which were miſtaken even by the great Veſalius for the impreſſions of the ribs.

2. The upper flat ſurface is like the lower one, but that it is traverſed by the SPINE, which is a very acute and high ridge of bone. Now the ſpine thus traverſing the bone from behind forwards, divides its upper ſurface into two unequal parts, of which the part above the ſpine is ſmaller, and that below the ſpine is larger. Each of theſe ſpaces has its name, one ſupra ſpinatus, and the other infra ſpinatus; and each of

them lodges a mufcle, named, the one the mufcûlus fupra fpinatus fcapulæ, as being above the fpine; the other mufculus infra fpinatus fcapulæ, as being below the fpine. A third mufcle is named fubfcapularis, as lying under the fhoulder blade, upon that concave furface which is towards the ribs; fo that the whole fcapula is covered with broad flat mufcles, whofe offices are to move the fhoulder bone in various directions, and which imprefs the fcapula with gentle rifings and hollows on its upper as well as on its lower furface.

3. The TRIANGULAR form of the fcapula muft be next obferved. The upper line of the triangle is the fhorteft; it is named the COSTA or border. This fuperior cofta of the fcapula receives thofe ftrong and flat mufcles that raife the fhoulder upwards. The lower border, which is named the COSTA INFERIOR, or the lower border of the fcapula, which receives no mufcles; becaufe it muft be quite free, to move and glide as the fcapula turns upon its axis, which is indeed its ordinary movement. But it gives rife to two fmaller mufcles, which, from being a little rounded, are named the mufculi teres, which round mufcles being implanted into the arm bone, pull it downwards.

The long fide of the fcapula, which bounds its triangular form backwards, is named the BASIS of the SCAPULA, as it reprefents the bafe of the triangle. This line is alfo like the two borders, a little thicker or fwelled out; and this edge receives many powerful mufcles, which lie flat upon the back, and coming to the fcapula, in a variety of directions, can turn it upon its axis, fometimes raifing, fometimes depreffing the fcapula; fometimes drawing it backwards; and fometimes fixing it in its place, according to the various fets of fibres which are put into action.

4. The GLENOID, OR ARTICULATING CAVITY of the fcapula, is on the point or apex of this triangle. The fcapula is more ftrictly triangular in a child, for it terminates almoft in a point or apex; and this articulating furface

furface is a feparate offification, and is joined to it in the adult. The fcapula towards this point terminates in a flat furface, not more than an inch in diameter, very little hollowed, and fcarcely receiving the head of the fhoulder bone, which is rather laid upon it than funk into it: it is indeed deepened a little by a circular griftle, which tips the edges or lips of this articulating furface, but fo little, that it is ftill very fhallow and plain, and luxations of the fhoulder are infinitely more frequent than of any other bone.

5. This head, or glenoid cavity of the fcapula, is planted upon a narrower part, which tends towards a point, but is finifhed by this flat head; this narrower part is what is named the NECK of the SCAPULA, which no doubt fometimes gives way, and breaks. A rough line bordering the glenoid cavity receives the capfular ligament, or rather the capfule arifes from that bordering griftle, which I have faid tips this circle.

6. The SPINE of the SCAPULA is that high ridge of bone, which runs the whole length of its upper furface, and divides it into two fpaces for the origin of the fupra and infra fpinatus mufcles. It is high, and very fharp, ftanding up at one place to the height of two inches. It is flattened upon the top, and with edges, which, turning a little towards either fide, give rife to two ftrong fafciæ, (i. e.) tendinous membranes, which go from the fpine, the one upwards to the upper border of the fcapula, the other downwards to the lower border; fo that by thefe ftrong membranes, the fcapula is formed into two triangular cavities, and the fupra and infra fpinatus mufcles rife not only from the back of the fcapula, and from the fides of its fpine, but alfo from the inner furface of this tenfe membrane. The fpine traverfes the whole dorfum, or back of the fcapula; it receives the trapezius mufcle, that beautiful triangular mufcle which covers the neck like a tippet, whence it has its name; and the fpine beginning low at the bafis of the fcapula, gradually rifes as it advances forwards, till it terminates in that high point or pro-

montory

montory which forms the tip of the ſhoulder, and overhangs and defends the joint.

7. This high point is named the ACROMION PROCESS. It is the continuation and ending of the ſpine, which at firſt riſes perpendicularly from the bone, but by a ſort of turn or diſtortion, it lays its flat ſide towards the head of the ſhoulder bone. At this place, it is thickened, flat and ſtrong, overhangs and defends the joint, and is not merely a defence, but almoſt makes a part of the joint itſelf; for, without this proceſs, the ſhoulder bone could not remain a moment in its ſocket; every ſlight accident would diſplace it. The acromion prevents luxation upwards, and is ſo far a part of the joint, that when it is full under the acromion, the joint is ſafe; but when we feel a hollow, ſo that we can puſh the points of the fingers under the acromion proceſs, the ſhoulder is luxated, and the ſocket empty. The point of the acromion, forming the apex of the ſhoulder, a greater projection of this point, and a fulneſs of the deltoid muſcle which ariſes from it, is a chief cauſe, and of courſe a chief mark of ſuperior ſtrength.

8. But there is ſtill another ſecurity for the joint; for there ariſes from the neck of the ſcapula, almoſt from the border of the ſocket, and its inner ſide, a thick, ſhort, and crooked proceſs, which ſtands directly forwards, and is very conſpicuous; and which, turning forwards with a crooked and ſharp point, ſomewhat like the back of a crow, is thence named the CORACOID PROCESS. This alſo guards and ſtrengthens the joint; though it cannot prevent luxations, it makes them leſs frequent, and moſt probably when the arm is luxated inwards it is by ſtarting over the point of this defending proceſs. A muſcle named coracoid, comes down from the point of this proceſs, and is inſerted into the middle of the ſhoulder bone, to draw the arm towards the ſide.

Now the glenoid ſurface, and theſe two proceſſes, form the cavity for receiving the ſhoulder bone. But ſtill, as if nature could not form a joint at once ſtrong and

and free, this joint which performs quick, free, and eaſy motions, is too ſuperficial to be ſtrong. Yet there is this compenſation, that the ſhoulder joint, which could not reſiſt, if fairly expoſed to ſhocks and falls, belongs to the ſcapula, which, ſliding eaſily upon the ribs, yields, and ſo eludes the force. Falls upon the ſhoulder do not diſlocate the ſhoulder; that accident almoſt always happens to us in putting out the hand to ſave ourſelves from falls; it is luxated by a twiſting of the arm, not by the force of a direct blow.

THE CLAVICLE.—The clavicle, or collar bone, named clavicle from its reſemblance to an old faſhioned key, is to the ſcapula a kind of hinge or axis on which it moves and rolls; ſo that the free motion of the ſhoulder is made ſtill freer by the manner of its connection with the breaſt.

The clavicle is placed at the root of the neck, and at the upper part of the breaſt: it extends acroſs from the tip of the ſhoulder to the upper part of the ſternum; it is a round bone, a little flattened towards the end which joins the ſcapula; it is curved like an Italic *S*, having one curve turned out towards the breaſt: it is uſeful as an arch ſupporting the ſhoulders, preventing them from falling forwards upon the breaſt, and making the hands ſtrong antagoniſts to each other, which, without this ſteadying, they could not have been.

1. The thoracic end, that next the ſternum, or what may be called the inner head of the clavicle, is round and flat, or button-like; and it is received into a ſuitable hollow on the upper piece of the ſternum. It is not only like other joints ſurrounded by a capſule or purſe; it is further provided with a ſmall moveable cartilage, which, (like a friction-wheel) in machinery, ſaves the parts, and facilitates the motion, and moves continually as the clavicle rolls.

2. But the outer end of the clavicle is flattened as it approaches the ſcapula, and the edge of that flatneſs is turned to the edge of the flattened acromion, ſo that they touch but in one ſingle point this outer end of the clavicle, and the correſponding point of the acromion,

mion, are flattened and covered with a cruſt of cartilage; but the motion here is very ſlight and quite inſenſible; they are tied firmly by ſtrong ligaments; and we may conſider this as almoſt a fixed point; for there is little motion of the ſcapula upon the clavicle; but there is much motion of the clavicle upon the breaſt: for the clavicle ſerves as a ſhaft or axis, firmly tied to the ſcapula, upon which the ſcapula moves and turns, being connected with the trunk only by this ſingle point, viz. the articulation of the clavicle with the breaſt bone.

The OS HUMERI is one of the trueſt of the cylindrical bones; it is round in the middle; but it appears twiſted and flattened towards the lower end; and this flatneſs make the elbow joint a mere hinge, moving only in one direction. It it again regular and round towards the upper end, dilating into a large round head, where the roundneſs forms a very free and moveable joint, turning eaſily in all directions.

1. The HEAD of this bone is very large; it is a neat and regular circle; but it is a very ſmall portion of a large circle, ſo that it is flat: and this flatneſs of the head, with the ſhallowneſs of its glenoid cavity, makes it a very weak joint, eaſily diſplaced, and nothing equal to the hip joint for ſecurity and ſtrength.

2. The NECK of this bone cannot fairly be reckoned ſuch; for, as I have explained in ſpeaking of the neck of the thigh bone, this neck of the humerus, and the necks of moſt bones (the thigh bone ſtill excepted), are merely a rough line cloſe upon the head of the bone, without any ſtraitening or intermediate narrowneſs, which we can properly call a neck. The roughneſs round the head of the ſhoulder bone is the line into which the capſular ligament is implanted.

3. The TUBEROSITIES of the os humeri are two ſmall bumps of unequal ſize (the one called the greater, the other the ſmaller tuberoſity of the os humeri), which ſtand up at the upper end of the bone, juſt behind the head: they are not very remarkable. Though infinitely ſmaller than the trochanter of the thigh bones, they ſerve ſimilar uſes, viz. receiving the great muſcles which

which move the limb. The GREATER TUBEROSITY is higher towards the outer ſide of the arm, and receives the ſupra ſpinatus muſcle; while the infra ſpinatus and teres minor muſcles, which come from the lower part of the ſcapula are implanted into the bone a little lower. The LESSER TUBEROSITY has alſo a great muſcle fixed into it, viz. the ſub-ſcapularis muſcle.

4. The two tuberoſities form betwixt them a groove, which is pretty deep; and in it the long tendon of the biceps muſcle of the arm runs: and as it runs continually, like a rope in the groove of a pully, this groove is covered in the freſh bones with a thin cartilage, ſmooth, and like the cartilages of joints.

The os humeri, at its lower part, changes its form, is flattened and compreſſed below, and is ſpread out into a great breadth of two inches or more; where there is formed on each ſide, a ſharp projecting point (named condyle), for the origin of great muſcles; and in the middle, betwixt the two condyles, there is a grooved articulating ſurface, which forms the hinge of the elbow.

1. At the lower end of the bone, there are two ridges, one leading to either condyle, which it is of ſome conſequence to obſerve; for the elbow joint is a mere hinge, the moſt ſtrictly ſo of any joint in the body: it has, of courſe, but two motions, viz. flexion and extenſion; and it has two muſcles, chiefly one for extending, the other for bending the arm: the flexor muſcle lies on the forepart, and the extenſor on the back part of the arm; and ſo the whole thickneſs of the arm is compoſed at this place, of theſe two muſcles and of the bone: but that the fore and back parts of the arm might be thoroughly divided, the bone is flattened betwixt them; and that the diviſion might extend beyond the mere edges of the bone, there are two faſciæ or tendinous webs which go off from either edge of the humerus, and which continue to divide the fore from the back muſcles, giving theſe muſcles a broader origin; they are named, from their office, intermuſcular mem-

membranes; and this is the meaning of the two ridges which lead to the two condyles.

2. The two projections in which these edges end, are named CONDYLES. The condyles of the thigh bone are the broad articulating surfaces by which that bone is joined with the tibia, while the condyles of the shoulder bone are merely two sharp projecting points for the origin of muscles, which stand out from either side of the joint, but which have no connection with the joint. The chief use of the condyles of the shoulder bone is to give a favourable origin, and longer fulcrum for the muscles of the fore-arm, which arise from these points. The outer tubercle being the smaller one, gives origin to the extensor muscles, where less strength is required. But the inner tubercle is much longer, to give origin to the flexor muscles with which we grasp, which require a bolder and more prominent process to arise from; for greater power is needed to perform such strong actions as grasping, bending, pulling, while the muscles which extend the fingers need no more power than just to antagonise or oppose the flexors; their only business being to unfold or open the hand, when we are to renew the grasp.

It is further curious to observe, that the inner tubercle is also lower than the other, so that the articulating surface for the elbow joint is oblique, which makes the hand fall naturally towards the face and breast, so that by being folded merely without any turning of the os humeri, the hands are laid across.

3. The articulating surface which stands betwixt these condyles, forms a more strict and limited hinge than can be easily conceived, before we explain the other parts of the joint. The joint consists of two surfaces; first a smooth surface, upon which the ulna moves only backwards and forwards; and, secondly, of a small knob upon the inner tubercles, which has a neat round surface, upon which the face or socket belonging to the button-like end of the radius rolls. These two surfaces are called the small head, and the cartilaginous pully of the humerus.

4. Belonging to the joint, and within its capſular ligament, there are two deep hollows, which receive certain proceſſes of the bones of the fore arm. One deep hollow on the forepart of the humerus, and juſt above its articulating pully, receives the horn-like, or coronoid proceſs of the ulna, viz. foſſa coronoidea; the other receives the olecranon, or that proceſs of the ulna which forms the point of the elbow, viz. foſſa olecranalis.

RADIUS AND ULNA.

The radius and ulna are the two bones of the fore arm. The radius, named from its reſemblance to the ray or ſpoke of a wheel; the ulna, from its being often uſed as a meaſure. The radius belongs more peculiarly to the wriſt, being the bone which is chiefly connected with the hand, and which turns along with it in all its rotatory motions: the ulna, again, belongs more ſtrictly to the elbow joint, for by it we perform all the actions of bending or extending the arm.

The ulna is in general of a triangular or priſmatic form, like the tibia, and the elbow is formed by the ulna alone; for, there is a very deep notch or hinge-like ſurface, which ſeems as if it had been moulded upon the lower end of the humerus, embraces it very cloſely, and takes ſo ſure a hold upon the humerus, that it allows not the ſmalleſt degree of lateral motion, and almoſt keeps its place in the dry ſkeleton: without the help of ligaments or muſcles, it preſents, in profile, ſomewhat of the ſhape of the letter S, and therefore is named the SIGMOID CAVITY of the ulna. 2. But this ſigmoid cavity were a very imperfect hinge without the two proceſſes by which it is guarded before and behind; the chief of theſe is, the OLECRANON or large bump, which forms the extreme point upon which we reſt the elbow. It is a big and ſtrong proceſs, which, checking into a deep hollow on the back of the humerus, ſerves two curious purpoſes; it ſerves as a long lever for the muſcles which extend, or make ſtraight the fore arm; and when by the arm being extended, it checks into its place,

place, it takes ſo firm a hold upon the hinge or joint of the os humeri, as to ſecure the joint in pulling, and ſuch other actions, as might cauſe a luxation forwards. 3. The other proceſs which guards the elbow joint is named the CORONOID PROCESS, from its horn or pointed form; it ſtands up perpendicularly from the upper or fore part of the bone; it forms the fore part of the ſigmoid cavity, and completes the hinge. It is uſeful, like the olecranon, in giving a fair hold and larger lever to the muſcles, and to ſecure the joint; for the arm being extended, as in pulling, the olecranon checks into its place, and prevents luxation forwards; and the arm again being bent, as in ſtriking, puſhing, or ſaving ourſelves from falls, the coronoid proceſs prevents luxation backwards; ſo the joint conſiſts of the olecranon and the coronoid proceſs as the two guards, and of the ſigmoid cavity or hollow of articulation betwixt them: but the ſmaller or upper head of the radius alſo enters into the joint, and lying upon the inner ſide of the coronoid proceſs, it makes a ſmall hollow there, in which it rolls; and this ſecond hollow, touching the edge of the ſigmoid cavity, forms a double ſigmoid cavity, of which the firſt, or GREATER SIGMOID CAVITY, is for receiving the lower end of the humerus; and the ſecond, or LESSER SIGMOID CAVITY, for receiving the upper head of the radius. 4. The form of the bone being priſmatic or triangular, it has, like the tibia, three ridges, one of which is turned towards a correſponding ridge in the radius, and betwixt them the interoſſeous ligament is ſtretched; and this interoſſeous ligament fills all the arch or open ſpace betwixt the radius and ulna, and ſaves the neceſſity of much bone; gives as firm an origin to the muſcles as bone could have done, and binds the bones of the fore arm together ſo ſtrongly, that though the ulna belongs entirely to the elbow joint, and the radius as entirely to the wriſt, they have never been known to depart from each other. 5. The ulna, bigger at the elbow, grows gradually ſmaller downwards, till it terminates almoſt in a point. It ends below in a ſmall round head, which is named the LOWER

HEAD

HEAD of the ulna, which ſcarcely enters into the joint of the wriſt; but being received into a hollow on the ſide of the radius, the radius turns upon the lower head of the ulna, like an axis or ſpoke.

6. Below this little head, the bone ends towards the ſide of the little finger, in a ſmall rounded point, which is named the STYLOID PROCESS of the ulna; it is chiefly uſeful in giving a ſtrong adheſion to the ligament which ſecures the wriſt there. And as the ſtyloid proceſs and the olecranon, the two extremities of the ulna, are eaſily and diſtinctly felt, the length of this bone has been uſed as a meaſure, and ſo it was named cubitus by the ancients, and is named ulna by us.

RADIUS. The radius is the ſecond bone of the fore arm, has its poſition exactly reverſed with that of the ulna: for the ulna belonging to the elbow, has its greater end upwards; the radius belonging to the wriſt, has its greater end downwards; and while the ulna only bends the arm, the radius carries the wriſt with a rotatory motion, and ſo entirely belongs to the wriſt, that it is called the manubrium manus, as if the handle of the hand.

1. The BODY of the radius is larger than that of the ulna. The tranſverſe ſtrength of the arm depends more upon the radius, which has more body and thickneſs, is more ſquared, and is arched in ſome degree ſo as to ſtand off from the ulna, without approaching it, or compreſſing the other parts. The radius lies along the upper edge of the fore arm, next to the thumb, and being, like the ulna, of a priſmatic or triangular form, it has one of its angles or edges turned towards the ulna to receive the interoſſeous ligament.

2. The UPPER HEAD of the radius is ſmaller; of a round, flattiſh, and button-like ſhape, and lies ſo upon the lower end of the ſhoulder bone, and upon the coronoid proceſs of the ulna, that it is articulated with either bone; for 1ſt, The hollow of its head is directly oppoſed to the little head of the os humeri; and, 2dly, The flat ſide of its button-like head rubs and turns upon the ſide of the coronoid proceſs, making a ſocket

ſocket there, which is called the leſſer ſigmoid cavity of the ulna.

3. Immediately behind the round flat head, is a narrowneſs or ſtraitening, called the NECK of the radius; round this neck there is a collar or circular ligament (named the coronoid ligament of the radius,) which keeps the bone ſecurely in its place, turning in this ligamentous band, like a ſpindle in its buſh or ſocket; for the radius has two motions, firſt accompanying the ulna in its movements of flexion and extenſion; and, ſecondly, its own peculiar rotation, in which it is not accompanied in return by the ulna; but the ulna continuing ſteady, the radius moves, and turns the wriſt.

4. Immediately under this neck, and juſt below the collar of the bone, there is a prominent bump, like a flat button, ſoldered upon the ſide of the bone, which is the point into which the biceps flexor cubiti, or bending muſcle of the fore arm is inſerted.

5. The upper head is exceedingly ſmall and round, while the LOWER HEAD ſwells out, broad and flat, to receive the bones of the wriſt. There are two greater bones in the wriſt, which form a large ball, and this ball is received into the lower end of the radius: the impreſſion which theſe two bones make there, is pretty deep, and ſomewhat of a boat-like ſhape; whence it is called (like the articulating ſurface of the tibia), the ſcaphoid cavity of the radius; and on the edge of the radius, next to the thumb, the bone ends in a ſort of peak or ſharper point, which is named (though with very little meaning), the STYLOID PROCESS of the radius.

So the ſcaphoid cavity of the radius forms the joint with the wriſt; but there is another ſmall cavity, on the ſide of the radius, near to the little head of the ulna, into which the leſſer head of the ulna is received, and this is encloſed in a proper and diſtinct capſule. The little head of the ulna does not deſcend ſo low as to have any ſhare in forming the wriſt. There are properly two diſtinct joints; the great joint of the wriſt, moving upon the radius, the other a little joint within

this

this of the radius, rolling upon the ulna, and carrying the wriſt along with it.

OF THE HAND AND FINGERS.

THE wriſt is the moſt complex part of all the bony ſyſtem, and is beſt explained in a general way, by marking the three diviſions of the hand, into the carpus or wriſt bones; the metacarpus, or bones that ſtand upon the wriſt; and the fingers conſiſting each of its three joints. 1. The carpus or wriſt is a congeries of eight ſmall bones, grouped together, into a very narrow ſpace, very firmly tied together, by croſs ligaments, making a ſort of ball or nuclæus, a ſolid foundation, or centre for the reſt of the hand. 2. The metacarpus is formed of five long bones, founded upon the carpal bones, and which, departing from that centre in ſomewhat of a radiated form, give, by their ſize and ſtrength, a firm ſupport to each individual finger, and by their radiated or ſpoke-like form allow the fingers freer play. 3. The fingers, conſiſting each of three very moveable joints, are ſet free upon the metacarpus, ſo as to ſhow a curious gradation of moving in all theſe parts; for the carpal bones are grouped together into a ſmall nuclæus, firm, almoſt immoveable, and like the nave of a wheel; then the metacarpal bones founded upon this, are placed like the ſpokes or fellies of the wheel, and having a freer motion; and, laſtly, the fingers by the advantage of this radiated form, in the bones upon which they are placed, move very nimbly, and have a rotatory as well as a hinge-like motion; ſo that the motion is graduated and proportioned in each diviſion of the hand; and even where there is no motion, as in the carpus, there is an elaſticity, which, by gentle bendings, accommodates itſelf to the more moveable parts.

The CARPUS, or WRIST.—Looking upon the external ſurface of the carpus, we count eight ſmall bones diſpoſed in two rows, with one bone only a little removed from its rank; and we obſerve that the whole is arched outwards, to reſiſt injuries, and to give ſtrength; and that the bones lie like a pavement, or

 like

like the ſtones of an arch, with their broader ends turned outwards. On the internal ſurface, again, we find the number of bones not ſo eaſily counted; for their ſmaller ends are turned towards the palm of the hand, which being a concave ſurface, the narrow ends of the wedges are ſeen huddled together in a leſs regular form, crowded, and lapped over each other; but in this hollow, the four corner bones are more remarkable, projecting towards the palm of the hand, ſo as to be named proceſſes: and they do indeed perform the office of proceſſes; for there ariſes from the four corner points, a ſtrong croſs ligament, which binds the tendons down, and makes under it a ſmooth floor or gutter for them to run in.

The individual bones of the carpus are ſmall, cornered, and very irregular bones, ſo that their names do but very poorly repreſent their form. To deſcribe them without ſome help of drawing, or demonſtration, is ſo very abſurd, that a deſcription of each of them ſeems more like a riddle, than like a ſerious leſſon: it cannot be underſtood, and indeed it need hardly be remembered; for all that is uſeful, is but to remember the connection and place, and the particular uſes of each bone; in reading of which, the ſtudent ſhould continually return to the plates, or he muſt have the bones always in his hand.

I. ROW FORMING THE WRIST.

1. Os scaphoides—The boat-like bone. This name of boat-like bone, or boat-like cavity, has been always a favourite name, though a very unmeaning one. The ſcaphoid bone is not worthy of notice merely from its being the largeſt, but alſo as it forms a chief part of the joint of the wriſt; for it is this bone which is received into the ſcaphoid cavity of the radius; it is a very irregular bone, in which we need remember only theſe two points, the large round ſurface covered with cartilage, ſmooth, and anſwering to the cavity in the head of the radius; and the hook-like or projecting proceſs, which forms one of the corner points of the carpus,

and

and gives a hold to one corner of the ligament which binds down the tendons of the wrift.

2. The os LUNARE is named from one of its fides being fomewhat of the fhape of a half moon; it is next in fize to the fcaphoid bone, and is equal to it in importance; for they are joined together, to be articulated with the radius. This bone takes an equal fhare in the joint with the fcaphoid bone; and together, they form a great ball, fitting the focket of the radius, and of a long form, fo that the wrift is a proper hinge. The lunated edge of the os lunare is turned towards the fecond row of bones, and therefore is not feen. And the chief marks of this bone are its greater fize, its lunated edge turned towards the fecond row, and its round head forming the ball of the wrift joint.

3. The os CUNEIFORME, or wedge-like bone, is named rather perhaps from its fituation, locked in among the other bones, than ftrictly from its form. Its fide forming the convex of the hand, is broader; its point towards the palm of the hand is narrower: and fo far, we may fay, it is a wedge-like bone; but it is chiefly fo from its fituation, clofely wedged in betwixt the lunare and pifiform bones.

4. The os PISIFORME, is a fmall, neat, and round bone, named fometimes ORBICULAR, or round bone, but oftener pifiform, from its refemblance to a pea. It is placed upon the cuneiform bone, and it ftands off from the reft into the palm of the hand, fo as to be the moft prominent of all the corner bones; of courfe it forms one of the corner points or pillars of that arch, under which the tendons pafs. The pifiform bone is a little out of its rank, is very moveable, and projects fo into the palm, as to be felt outwardly, juft at the end of the ftyloid procefs of the ulna; it can be eafily moved and rolled about, and is the point into which is implanted one of the ftrong mufcles for bending the wrift.

2. ROW SUPPORTING THE METACARPAL BONES.

5. The fecond row begins with the TRAPEZIUM, a pretty large bone, which, from its name, we fhould

expect to find of a regular squared form; while it has, in fact, the most irregular form of all, especially when detached from the other bones. The chief parts to be remarked in the bone, are the great socket for the thumb; and as the thumb stands off from one side of the hand, this socket is rather on one side. There is also a little process which makes one of the corner points.

6. The TRAPEZOIDES is next to the trapezium, is somewhat like the trapezium, from which it has its name. It also resembles the cuneiform bone of the first row in its shape and size, and in its being jammed in betwixt the two adjoining bones.

7. The OS MAGNUM is named from its great size; not that it is the largest of all, nor even the largest bone of the second row, for the unciform bone is as big; but there is no other circumstance by which it is well distinguished. It is placed in the centre of the upper row, has a long round head, which is jointed chiefly with the lunated hollow of the os lunare; and this big head, and lunated hollow, make together a sort of socket, by which the second row moves upon the first.

8. The OS UNCIFORME, or hook-like bone, is named from a flat hook-like process, which projects towards the palm of the hand. This is one of the corner bones, and standing in the end of the row, it is wedged betwixt the os magnum of its own row, and the os cuneiforme of the first row. It is large and squared; but the thing chiefly remarkable is that process from which it takes its name; a long and flat process of firm bone, fairly unciform, or hook-like, and projecting far into the palm of the hand, which being the last and highest of the corner points, gives a very firm origin to the great ligament by which the tendons of the wrist are bound down.

All these bones of the carpus, when they are joined to each other, are covered with a smooth articulating cartilage, are bound to each other by all forms of cross ligaments, and are consolidated, as it were, into one great joint. They are in general, so firm as to be

ſcarcely liable to luxation; and although one only is called cuneiform, they are all ſomewhat of the wedge-like form, with their broader ends outwards, and their ſmaller ends turned towards the palm of the hand; they are like ſtones in an arch, ſo that no weight nor force can beat them in, if any force do prevail, it can beat others in only by forcing one out. A bone ſtarting outwards, and projecting upon the back of the hand, is the only form of luxation among theſe bones, and is extremely rare.

METACARPUS. — The metacarpus is compoſed of five bones, upon which the fingers are founded. They are big ſtrong bones, brought cloſe together at the root, but wider above; for the lower heads are ſmall and flat, and grouped very cloſely together, to meet the carpal bones. But they ſwell out at their upper ends into big round heads, which keep the bones much apart from each other. Nothing of importance can be ſaid concerning the individual bones. To ſpeak of them individually is a mere waſte of time. We may obſerve of the metacarpal bones in general; 1. That their nearer heads being flat and ſquared, gives them a firm implantation upon their centre or nuclæus, the carpus; and they have ſcarcely any freer motion upon the carpal bones, than the carpal bones have upon each other. 2. That their lower heads being larger, keeps the bones apart from each other; and in the interſtices between them lie the interoſſeous muſcles. 3. That their divergence regulates the radiated or ſpreading form of the fingers, and gives them free play. And 4. That they ſtill preſerve the arched form of the carpal bones, being, with the carpal bones, convex outwardly, and concave inwardly, to form the hollow of the hand; and though they have little motion of flexion or extenſion, they bend towards a centre, ſo as to approach each other, increaſing the hollowneſs of the hand, to form what is called Diogenes's cup. It is farther neceſſary to obſerve, into how ſmall a ſpace the carpal bones are compreſſed, how great a ſhare of the hand the metacarpal

tacarpal bones form, and how far down they go into the hollow of the hand. For I have seen a surgeon, who, not having the smallest suspicion that their lower ends were so near the wrist as they really are, has, in place of cutting the bone neatly in its articulation with the carpus, broken it, or tried to cut it across in the middle.

FINGERS.—We commonly say, that there are five metacarpal bones; in which reckoning we count the thumb with the rest: but what is called the metacarpal of the thumb is properly the first phalanx, or the first proper bone of the thumb; so that the thumb, regularly described, has, like the other fingers, three joints.

THUMB.—The first bone of the thumb resembles the metacarpal bones in size and strength, but it differs widely in being set upon the carpus, with a large and round head; in being set off from the line of the other fingers, standing out on one side, and directly opposed to them, it rolls widely and freely, like other ball and socket joints: it is opposed to the other fingers in grasping, and, from its very superior strength, the thumb is named pollex, from pollere.

The FINGERS have each of them three bones:—1. The first bone is articulated with the metacarpal bones by a ball and socket; the socket, or hollow on the lower part of the first finger bone, being set down upon the large round head of the metacarpal bone. 2. The second and third joints of the fingers are gradually smaller, and though their forms do a good deal resemble the first joint, they are quite limited in their motions; have no rolling; are as strictly hinge joints as the knee or ancle are. 3. Here, as in other hinge joints, the capsule is so particularly strong at the sides, as to be named lateral ligaments. When these lateral ligaments are burst or cut, the finger turns in any direction; so that the motions of the fingers are limited rather by their lateral ligaments, than by any thing peculiar in the forms of the bones. 4. The face of each finger bone is grooved, so that the tendons, passing in the

the palm of the hand, run upwards along this groove or flatneſs of the fingers; and from either edge of this flatneſs, there riſes a ligament of a bridge-like form, which covers the tendons like a ſheath, and converts the groove into a complete canal. 5. The laſt joint or phalanx of each finger is flattened, rough, and drawn ſmaller gradually towards the point of the finger; and it is to this roughneſs that the ſkin and nail adhere at the point.

OF THE TEETH *.

THERE is naturally an inclination in the author of a ſyſtem to amplify ſome particular ſubjects, and to abridge, or beſtow leſs attention, on others which may to him appear leſs intereſting or curious. To reſtrain this tendency has been the moſt irkſome taſk which I have felt in completing the preſent work. The growth and ſtructure of the teeth forms an elegant and intereſting ſubject of enquiry; and it is difficult to compreſs the ſubject, ſo as to be conſiſtent with the arrangement of a ſyſtematic work.

As the general nature and uſe of the teeth are ſufficiently underſtood, there can be no objection to our beginning the preſent ſubject with conſidering the ſtructure of the human teeth.

OF THE STRUCTURE OF THE TEETH.

A tooth conſiſts of theſe parts.—1. The ENAMEL, a peculiarly hard layer of matter compoſing the ſurface of the body of the tooth. 2. The internal part, or inner ſubſtance of the tooth, is leſs ſtoney and hard than the enamel, but of a firmer ſtructure and more compact than common bone. 3. In regard to the form of the tooth, we may obſerve, that it is divided into the crown, the neck, and the fangs, or roots of the tooth, which go deep into the jaw. There is a cavity in the body of the tooth, and the tube of the fangs communicates with it. This cavity receives veſſels for ſupplying the remains of that ſubſtance upon which the tooth was originally formed. The roots of the teeth are received into the jaw by that kind of articulation which was called gomphoſis. They are not firmly wedged into the bone, for in conſequence of maceration, and the deſtruction of the ſoft parts, the teeth drop from the ſkull. There is betwixt the tooth and its ſocket in the jaw a common perioſteum.

* By Mr. Charles Bell.

OF

OF THE ENAMEL. The ſurface of a tooth, that which appears above the gum, is covered with a very denſe hard layer of matter, which has been called the enamel *. In this term there is ſome degree of impropriety, as aſſimilating an animal production with a vitreous ſubſtance, although the enamel very widely differs from the glaſſy fracture when broken. This matter beſtows the moſt eſſential quality of hardneſs on the teeth; and when the enamel is broken off, and the body of the tooth expoſed, the bony part quickly decays.

The enamel is the hardeſt production of the animal body. It ſtrikes fire with ſteel: in church-yard ſkulls it is obſerved to remain undecayed when the centre of the tooth has fallen into duſt. It has been found that the component parts of the enamel are nearly the ſame with thoſe of bone. In bone the phoſphate of lime is depoſited on the membranes, or cartilage, but this hardening matter of bones is a ſecretion from the veſſels of the part, and is accumulated around the veſſels themſelves: it is ſtill within the controul of their action, and is ſuffering the ſucceſſion of changes peculiar to a living part. In the enamel, the phoſphate of lime has been depoſited in union with a portion of animal gluten, and has no vaſcularity, nor does it ſuffer any change from the influence of the living ſyſtem. Although the hardening matter be principally phoſphate of lime, a ſmall proportion of the carbonate of lime enters into the compoſition both of bone and of enamel. But in enamel, according to Morichini and Gay Luſſac, there is fluat of lime, to which ingredient theſe chemiſts attribute the hardneſs of this cruſt †.

Although

* In brutes there is a conſiderable variety in the relative form of the enamel and bone of the tooth.

† By Mr. Hatchett's Experiments (Philoſ. Tranſact. 1799) we learn that bone conſiſts of phoſphate of lime, with a ſmall proportion of carbonate of lime. The ſhell of the crab and lobſter conſiſts of phoſphate of lime and carbonate of lime, the latter being in the greateſt quantity. The teſtaceous ſhells conſiſt entirely of carbonate of lime. The matter of bone and teeth conſiſts

Although we call the earthy depofit the hardening matter, yet it is the union of the glutinous matter which beftows the extreme hardnefs,! for, when the tooth is as yet within the jaw, and in an early ftage of its formation, the depofitation is foft, and its furface rough; but, by a change of action in the furface, which throws out this fecretion, the firft depofitation is penetrated with gelatinous fecretion, which either by this penetration fimply, or by caufing a new appofition of its parts, (its ftructure indeed looks like chryftallization,) beftows the denfity and extreme hardnefs on this cruft. When an animal is fed with madder, the colouring matter coming, in the courfe of the circulation, in contact with the earth of bone, is attracted by it, and is depofited upon it in a beautiful red colour. This colouring matter penetrates more than injection can be made to do in the dead body; and, as by this procefs of feeding, the enamel is not tinged, we have a convincing proof that the vafcular fyftem has no operation on the enamel after it is formed.

From the compofition of the enamel, we muft be aware of the baneful effects of acidulated wafhes and

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fifts of phofphate of lime and a fmall portion of carbonate depofited in the interftice of an animal fubftance, which is of the nature of cartilage, and proves to be gelatine. The bones of fifh differ from thofe of man and brutes, in the larger proportion of animal fubftance. Thefe chemical facts are, however, of little import to the anatomift, he is defirous of knowing what property of life thefe parts are endowed with; whether they are formed by a final depofitation, or are ftill under the influence of the circulating veffels, whether they poffefs a principle of felf-prefervation independent of vafcularity, or are like common dead matter altogether out of the fyftem.

The formation of bone has been very fully defcribed. The formation of fhell is more like that of teeth. The teftaceous fhell confifts of layers; the layers are formed fucceffively by fecretion from the animal body, and each fucceffive layer is broader than the preceding, anfwering to the encreafed circumference of the animal. Reaumeur broke the fhell of a fnail, and he found that when he covered the furface of the creature and prevented the exudation, no fhell was formed. There has been a queftion agitated regarding the poffibility of nutrition, without the intervention of veffels, which bears upon this fubject of the nature of fhell and teeth.

powders to the teeth: they diſſolve the ſurface, and give a deceitful whiteneſs to the teeth; they erode the ſurface, which it is not in the conſtitution of the part to reſtore.

OF THE CENTRAL BONY PART OF THE TOOTH.

The chemical compoſition, and the manner of combination of the matter forming the central part of the tooth, and of the fangs, is ſimilar to other bones of the body; but when we examine the hardneſs and the denſity of the tooth, and ſee that it is not even porous, or apparently capable of giving paſſage to veſſels, we doubt of its vaſcularity, and are apt to ſuppoſe that it holds its connection with the living jaw-bone by ſome other tenor than that of veſſels, and the circulation of the blood through it. The body and fangs of a tooth are covered with a perioſteum like other bones. The vaſcularity of the perioſteum, which ſurrounds the tooth, and the veſſels which enter by the fangs to the cavity of the tooth, ſeem to be a proviſion for ſupplying them plentifully with blood; but on further exmination, it will prove to be a means only of fixing the tooth in the ſocket, and of preſerving the ſenſibility of the nerve in the cavity of the tooth. As the bony part of the tooth has often been coloured by feeding young animals with madder, the reverſe of that experiment, convinces us there is no circulation in the enamel; this ſhould ſatisfy us that there is blood circulating through the body of the tooth, and that it undergoes the ſame changes by abſorption which the other bones are proved to do. But theſe experiments may have been made while the teeth were forming by a ſecretion from the pulp, and of courſe they might be coloured without the experiment affording a fair proof that the circulation continues in the tooth after it is formed.

OF THE VASCULARITY AND CONSTITUTION OF THE BONY PART OF THE TOOTH.

The teeth undergo changes of colour in the living body, to which it would appear they could not be liable as dead matter. They become yellow, tranſparent, and brittle

brittle with old age; and when a tooth has been knocked from its ſocket, and replaced, dentiſts have obſerved that it loſes its whiteneſs, and aſſumes a darker hue.

The abſorption of the roots in conſequence of the caries of the body of the tooth, and the abſorption of the fangs of the deciduous teeth, are further alledged in proof of their vaſcularity; not only the preſſure of the riſing tooth on the fangs of the temporary teeth will cauſe an abſorption of the latter, but the fangs of the temporary teeth will waſte and be abſorbed, ſo as to drop out without the mechanical preſſure of the permanent teeth, and before they have advanced to be in contact with the former.

The teeth ſeem acutely ſenſible; but a little conſideration teaches us that the hard ſubſtance of the teeth is not endowed with ſenſibility, and that it muſt be the remains of the vaſcular pulp, preſently to be deſcribed, occupying the centre of the tooth, which being ſupplied with nerves, gives the acute pain in tooth-ach. It is as a medium communicating or abſtracting heat, that the tooth itſelf gives pain. When wrought upon by the dentiſt, no ſenſation is produced unleſs the tremor be communicated to the centre, or unleſs the abrading, or cutting inſtruments, be ſo plied as to heat the tooth; then an acute pain is produced from the heat communicated to the centre; and ſo extremely cold ſubſtances, or liquids, taken into the mouth, produce pain, from the cold affecting the pulp through the body of the tooth.

As living parts, the teeth have adheſion to the perioſteum, and are connected with their internal pulp; but when they ſpoil, and are eroded, the diſeaſe ſpreads inwardly, probably deſtroying the life of the bony part of the tooth, the progreſs of which diſeaſe is marked by a change of colour penetrating beyond the caries towards the centre of the tooth. When this diſcolouration has reached the internal ſurface, the pain of tooth-ach is excited; the pulp, vaſcular and ſupplied with nerves, inflames, from a want of accordance with the altered ſtate of the tooth, juſt as the dead ſurface of a bone will inflame the central perioſteum and marrow. The extreme pain produced by this ſtate of the tooth probably

proceeds

proceeds from the delicate and ſenſible pulp ſwelling in the confinement of the cavity of the tooth.

In caries of the teeth, the body of the tooth is diſcoloured deep in its ſubſtance long before the pulp of the central cavity is expoſed by the progreſs of the caries. No exfoliation, or exoſtoſis, takes place upon that part of the tooth which is above the gum, which may be owing to the mere compactneſs of the oſſific depoſitions; for we know that the bones of greateſt denſity are the moſt apt to yield altogether to diſeaſed action, and die, inſtead of throwing off their ſurface in exfoliations, or taking any other variety of diſeaſed action.

In the further conſideration of this ſubject, there are circumſtances which will make us doubt of there being vaſcular action in the teeth, and perhaps incline us to believe that they poſſeſs a lower degree of life, and are leſs ſubject to change than other parts. Suppoſing the bony part of the tooth to be vaſcular, and to poſſeſs the principle of life, is not the firm adheſion and contact of the enamel to the body of the tooth a curious inſtance of a part deſtitute of life adhering to the ſurface of a living part, without producing the common effects of excitement and exfoliation, or inflammation, in the latter? Is the enamel, though not a vaſcular part, poſſeſſed of ſome quality which diſtinguiſhes it from foreign matter, or is the bony part of the tooth poſſeſſed of ſo low a degree of vaſcular action, that it is not excited by the contact and adherence of the enamel? We muſt ſuppoſe that ſome accordance ſubſiſts between the enamel, body, or fang of the tooth, and the gums.

In rickets, and molities oſſium, and other diſeaſes of debility in which the body waſtes, or the growth is retarded, the growth of the teeth is not retarded in the one caſe, nor are the grown teeth altered in their form or properties in the other. This appears to me to ſupport the idea of there being a diſtinction in the economy between the manner of the formation of the teeth, and of common bone. The effects which we perceive in the bony ſyſtem under theſe diſeaſes, are produced by the activity

activity of the abſorbents prevailing over the action of the red veſſels; while in the teeth no ſuch effect can take place, if they are formed by a depoſition of bony matter which is not re-abſorbed, nor ſubject to the revolution of depoſition and re-abſorption, which takes place in other parts of the body. Accordingly, we find in rickets, where the hardeſt bone yields, where the jaw-bone itſelf is diſtorted or altered in its form, that the teeth remain diſtinguiſhed for their ſize and beauty. In molities oſſium, I have found the teeth looſe, but hard in their ſubſtance. In rickets the teeth are large, and perfectly formed, while the jaws are ſtinted and interrupted in their growth. The conſequence of this is, that the teeth form a larger range than the jaw, and give a characteriſtic protuberance to the mouth.

When an adult tooth of one jaw is loſt, there appears to be a growth of the tooth of the oppoſite jaw; but I believe the tooth only projects from its ſocket a little further, in conſequence of the want of that preſſure to which it is naturally accommodated. The teeth of the *rodentia* are waſted by attrition and ſeem to grow. This is indeed a growth, but it is of the nature of the firſt formation of the tooth proceeding from the pulp *.

A very curious circumſtance is deſcribed by Haller, Buffon, Blumenbach, and others: — an iron ball is found in the ſubſtance of the tooth of an elephant, the bone of the tooth ſurrounding the ball. There is one example of this in the collection of Monro, and I have given an etching of a ſpecimen which I poſſeſs. Blumenbach gives a ſtill more intereſting example of a leaden ball immerſed in ivory. Now it is evident that a ball, perfect in its form, could not be ſtruck into the ſolid tooth. On ſtriking bone, a leaden bullet is flattened or made quite irregular in its ſhape, of which I have many examples before me. The ball muſt have pierced the pulp, or got into the cavity of the tooth when forming, ſo as to be encruſted and ſurrounded with the bony depoſition from the pulp.

The roots of the teeth are ſometimes found enlarged,

* See the ingenious Inaugural Diſſertation of Dr. Blake.

diſtorted,

diſtorted, or with exoſtoſis formed upon them. Again the cavity of the tooth is found filled up with what appears to be new matter, or around the fangs we often find a ſmall ſac of pus, which is drawn out in extracting the tooth. Nevertheleſs, in theſe examples of diſeaſe, there are no unequivocal marks of vaſcular action in the tooth; the unuſual form, or exoſtoſis of the roots, is produced by an original defect in the formation. The filling up of the cavity of the tooth is cauſed in the ſame way, or by the reſumed oſſific action of the pulp, in conſequence of the diſeaſe and deſtruction of the body of the tooth; and the abſceſſes which ſurround the fangs are cauſed by the death of the tooth, in conſequence of which it has loſt its ſympathy with the ſurrounding living parts, and becomes a ſource of irritation like any other foreign body.

We muſt conclude, that the whole of the phenomena diſplayed in the formation, adheſion, and diſeaſes of the teeth, ſhow them to be poſſeſſed of life, and that they have a correſpondence or ſympathy with the ſurrounding parts. But are we prepared to acquieſce in the opinion of Mr. Hunter, that they poſſeſs vitality while yet they have no vaſcular action within them? We naturally ſay, how can ſuch vitality exiſt independently of a circulation? But there are not wanting examples of an obſcure and low degree of life exiſting in animals ova, or ſeeds, for ſeaſons without a circulation; and if for ſeaſons, why not for a term of life? We never obſerve the animal economy providing ſuperfluouſly; and ſince there is no inſtance to be obſerved in which the teeth have ſhown a power of renovation, why ſhould they be poſſeſſed of vaſcularity and action to no uſeful end? All that ſeems neceſſary to them is, that they ſhould firmly adhere without acting as a foreign and extraneous body to the ſurrounding parts, and this, vitality, without vaſcular action, ſeems calculated to provide.

OF THE FORMATION AND GROWTH OF THE TEETH.

In the jaws of a child newly born, there are contained two ſets of teeth as it were in embryo: the deciduous, temporary, or milk teeth; and the permanent teeth. The neceſſity for this double ſet of teeth evidently is to be found in the incapacity of alteration of ſhape or ſize in the teeth, as in other parts of the body; the ſmaller teeth, which riſe firſt, and are adapted to the curve and ſize of the jaw-bone of an infant, require to be ſucceeded by others, larger, ſtronger, and carrying their roots deeper in the jaw.

Each tooth is formed in a little ſac, which lies betwixt the plates of bone that form the jaw-bone of the fœtus, or child, under the vaſcular gum, and connected with it.

When we open one of theſe ſacs at an early period of the formation of the tooth, a very curious appearance preſents itſelf: a little ſhell of bone is ſeen within the ſac, but no enamel is yet formed. Upon raiſing the ſhell of bone, which is of the ſhape of the tooth, and is the outer layer of the bony ſubſtance of the tooth, a ſoft vaſcular ſtool, or pulp *, is found to have been the mould on which this outer layer of oſſific matter has been formed; and a further obſervation will lead us to conclude, that this bony part of the tooth is in the progreſs of being formed by ſucceſſive layers of matter thrown out from the ſurface of this vaſcular pulp; though many have explained the formation of the tooth, by ſuppoſing that the layers of this pulp were ſucceſſively oſſified.

If we now turn our attention to the ſtate of thoſe teeth which we know to be later of riſing above the gum, we ſhall find the oſſification ſtill leſs advanced, and a mere point, or perhaps ſeveral points of the depoſited matter on the top of the pulp.

The pulp, or vaſcular papilla on which the tooth is

* Le noyau, la coque, or le germe de la dent, by the French authors.

formed,

formed, has not only this peculiar property of oſſification, but, as the period of revolution advances, where it forms the rudiments of the molares for example, its baſe ſplits ſo as to form the mould of two, three, or four fangs, or roots ; for around theſe diviſions of the pulp the oſſific matter is thrown out ſo as to form a tube, continued downwards from the body of the tooth. Gradually, and by ſucceſſive layers of matter on the inſide of this tube, it becomes a ſtrong root, or fang, and the bony matter has ſo encroached on the cavity, that only a ſmall canal remains, and the appearance of the pulp is quite altered, having ſhrunk in this narrow ſpace.

We have ſaid that the tooth forming on its pulp, or vaſcular bed, is ſurrounded with a membrane giving the whole the appearance of a little ſac. This membrane has alſo an important uſe. It is vaſcular alſo as the pulp is, but it is more connected with the gums, and receives its veſſels from the ſurface, while the pulp, lying under the ſhell of the tooth, receives its blood-veſſels from that branch of the internal maxillary artery which takes its courſe in the jaw.

The enamel is formed after the body of the tooth has conſiderably advanced towards its perfect form. It is formed by a ſecretion from the capſule, or membrane, which inveſts the teeth *, and which is originally continuous with the lower part of the pulp. The enamel is thicker at the point, and on the body of the tooth, than at its neck. Mr. Hunter ſuppoſed that the capſule always ſecreting, and the upper part of the tooth being formed firſt, it would follow, of courſe, that the point and body of the tooth would be covered with a thicker depoſition ; but it rather appears that that part of the ſac oppoſite to the upper part, and body of the tooth, has a greater power of ſecreting, being in truth more vaſcular and ſpongy ; for the whole of the body of the bony part

* This outer ſac has been called *chorion*, from the numerous veſſels diſtributed upon it. See Heriſſant.

 of

of the tooth is formed before the enamel inveſts the tooth.

We are indebted to M. Heriſſant for much of the explanation of the manner in which the enamel is formed. He deſcribes the ſac *, its attachment to the pulp, and to the neck of the teeth, — as the tooth advances to its perfect form, the ſac alſo changes. At firſt it is delicate and thin, but it thickens apace. And he aſſerts, that if after this progreſs is begun you examine the inner ſurface of it with a glaſs, you will perceive it to be compoſed of little veſicles in regular order, and which ſometimes have a limpid fluid contained in them. This liquid exuded upon the ſurface of the teeth he ſupppoſes to form the enamel. He explains alſo how this ſac, originally inveſting the body and neck of the tooth, being pierced by the edge of the tooth, and the tooth riſing through it, is inverted, and by ſtill keeping its connection with the circle of the crown of the tooth, riſes up in connection with the gum, and in ſome degree forms the new gum which ſurrounds the tooth.

The ſac which encloſes the rudiments of the tooth conſiſts of a double membrane. The outer membrane is of a looſer texture, and vaſcular; the inner is vaſcular alſo, but delicate and ſoft. Mr. Hunter ſaid, that while the tooth is within the gum, there is always a mucilaginous fluid like the ſinovia in the joints between this membrane and the pulp of the tooth. I do not imagine that the enamel is produced by the concretion of this humor, which we may find at any period of the growth of the body of the tooth; but that the ſecreting ſurface changes the nature of its action, when the bone of the tooth is perfected in its outer layer.

* Reſſemble aſſez à une petite bourſe fermée.

OF THE TEETH OF SOME QUADRUPEDS.

This ſubject of the formation of teeth would be incomplete if we left unexplained the peculiar ſtructure of the teeth of gramenivorous animals.

Mr. Corſe, in a curious paper in the Philoſophical Tranſactions of London for the year 1799, deſcribes the grinding tooth of an *elephant* in the following terms: In deſcribing the ſtructure of the grinders, it muſt be obſerved, that a grinder is compoſed of ſeveral diſtinct laminæ or teeth, each covered with its proper enamel; and that theſe teeth are merely joined to each other by an intermediate ſofter ſubſtance, acting like cement.

The ſtructure of the grinders, even from the firſt glance, muſt appear very curious, being compoſed of a number of perpendicular laminæ, which may be conſidered as ſo many teeth, each covered with a ſtrong enamel, and joined to one another by the common oſſeous matter. This being much ſofter than the enamel, wears away faſter, by the maſtication of the food; and, in a few months after ſome of theſe teeth cut the gum, the enamel remains conſiderably higher, ſo that the ſurface of each grinder ſoon acquires a ribbed appearance, as if originally formed with ridges.

The pulp of gramenivorous animals is not ſhaped like that which forms the human tooth; it conſiſts of ſeveral proceſſes united at their baſe. The capſule has alſo proceſſes which hang into the interſtices of the pulp; the pulp forms a ſhell of bone which in time covers it. The proceſſes of the capſule, which of courſe hang into the interſtices of this layer of bone (which has taken the exact form of the pulp), form over the bone layers of enamel. The tooth now conſiſts of conical proceſſes of bone, united at their roots, and the ſurfaces of theſe proceſſes have depoſited on them the enamel. The membraneous productions of the capſule having completed the enamel, change the nature of their ſecretion ſomewhat, and throw out a bony matter, which Dr. Blake has called the *cruſta petroſa*. By the formation of this laſt matter of the tooth the pro-

ceſſes which ſecrete are encroached upon ſo much, that they ſhrink altogether, and into the place left by them after they have loſt their power of ſecreting, foreign matter is ſometimes introduced by maſtication *.

The effect of this formation is to make the layers of the enamel pervade the whole ſubſtance of the tooth, the better to make it ſtand againſt the continued attrition neceſſary in the grinding and rumination of the herbiverous and gramenivorous animals. From this ſtructure of gramenivorous teeth, the human inciſors are the moſt remote. The grinders have a form which approaches towards it.

OF THE GROWTH OF THE SECOND SET OF TEETH, AND THE SHEDDING OF THE FIRST.

The firſt, or deciduous ſet of teeth, being adapted only for the jaws of a child, are deſtined to be ſhed, and to give place to the adult, or permanent ſet of teeth. Accordingly, in obſerving the progreſs of the formation of the firſt teeth, the rudiments of the ſecond may alſo be ſeen in the fœtus of the ſeventh or eighth month; and in the fifth and ſixth month after birth, the oſſification begins in them. The rudiments of the permanent teeth may be obſerved even when the ſac is very ſmall, and appear like a filament ſtretching up to the neck of the ſac of the deciduous teeth †. Theſe ſacs lie on the inner ſide of the jaw-bone, and when further advanced, the necks of the two ſacs (both as yet under the gum) are united; but when the firſt teeth are fully formed, and have riſen above the gum, the alveolar proceſſes have been at the ſame time formed around them, and now the ſacs of the permanent teeth have a connection with the gums through a ſmall foramen in the jaw-bone, behind the ſpace through which the firſt teeth have ſhot.

* See a paper of Mr. Home's in the Phyloſophical Tranſactions, and Dr. Blake's Inaugural Diſſertation.

† See the plate of the Teeth.

The

The opinion entertained, that the ſecond ſet of teeth puſh out the firſt, is erroneous, for the change on the deciduous and the growing teeth ſeems to be influenced by laws of coincidence indeed, but not of mechanical action. Sometimes we obſerve the falling tooth waſted at the root, or on the ſide of the fang, by the preſſure of the riſing tooth. Now here we ſhould ſuppoſe that the newly-formed tooth ſhould be the moſt apt to be abſorbed by the preſſure of the root of the deciduous tooth, did we not recollect that the new tooth is inveſted with the hard enamel, while the preſſure on the other is upon the the bony root. But there is more than this neceſſary to the explanation of the ſhedding of the teeth, for often the fang is waſted while the tooth adheres only by the gum, and the permanent tooth has made little progreſs in its elevation, and has not preſſed upon it. This decay and waſting of the fangs of the teeth looks more like a ſatisfactory proof of their vaſcularity, than any other change to which they are ſubject.

Yet there ſeems to be no reaſon why we ſhould not ſuppoſe, that as the rudiments of the teeth riſe into action at a particular time, and form the bony centre of the tooth, the decompoſition ſhould be effected by ſimilar laws; that at a particular period the tooth ſhould decay, and that the decay of the tooth ſhould begin with the deſtruction of the fangs. Either the bony part of the tooth has a tendency to diſſolution, independently of a circulation of blood through it, and that as the roots waſte the ſurrounding vaſcular parts abſorb its ſubſtance; or the ſurrounding vaſcular ſubſtance operates on the tooth diſſolving, and abſorbing it, as it is ſaid a dead bone is abſorbed, when placed upon an ulcer.

It is no proof of the firſt ſet being puſhed out by the ſecond ſet of teeth, that if the permanent teeth do not riſe, the firſt will remain, their roots unwaſted and firm even to old age; for ſtill I contend, that there is an agreement and coincidence betwixt the two ſets of teeth in their changes, and alſo in the alveoli, by which they are ſurrounded; but this is not produced by the preſ-

fure of the rifing teeth. When a dentift fees a tooth feated out of the proper line, and draws it, and finds that he has made the miftake of extracting the adult tooth, letting the milk tooth remain, he muft not expect that the milk tooth will keep its place, for the contrary will happen; it will in general fall out.

The old and the new teeth are lodged in diftinct compartments of the jaw-bone, and what is more curious, their alveoli are diftinct, for as the roots of the firft teeth decay, their alveolar proceffes are abforbed, while again, as the new teeth rife from their deep feat in the jaw-bone, they are accompanied with new alveoli; and the chief art of the dentift in fhifting the feat of the teeth, is gradually to pufh them along the jaw, notwithftanding the bony partitions or alveoli and proceffes, fo as to bring them into equal and feemly lines. It is curious to obferve, that the alveoli will by the falling out of one tooth, or the operation of wedging betwixt the teeth, change their place in the jaw.

When a tooth is loft, it appears as if the fpace it occupied were partly filled up by an increafed thicknefs of the adjacent teeth, and partly by the lengthening of that which is oppofite: indeed, this appearance has been brought as a proof of the continual growth of teeth. But there is a fallacy in the obfervation; for when the fpace appears to have become narrow by the approximation of the two adjacent teeth, it is not owing to any increafe of their breadth, but to their moving from that fide where they are well fupported to the other fide where they are not. For this reafon they get an inclined direction; and this inclination may be obferved in feveral of the adjoining teeth *.

No circumftance can better illuftrate how perfect the dependence of the alveoli is upon the teeth, than that of their being thrown off with them in extenfive exfoliations. I have a fpecimen of this in my collection, where the whole circle of the alveolar proceffes and teeth is thrown off. This happened after the confluent

* Mr. J. Hunter.

fmall-

ſmall-pox. I think I recollect a ſimilar caſe occurring to Dr. Blake. In thoſe tumors which ariſe from the alveoli and gums, filling the mouth with a cancerous maſs, and ſoftening the upper part of the jaw, there is no eradicating the diſeaſe but by taking away the whole adventitious part of the jaw which belongs to the teeth, and leaving only the firmer baſe. But even this operation will be too often unſucceſsful.

The tranſplanting of teeth preſents another very intereſting phenomenon. A tooth recently drawn, and placed accurately into a ſocket from which one has been taken, will adhere there: nay, it will even adhere to any living part, as in the comb of a cock. This, however, proves only that the tooth poſſeſſes vitality; for after it is taken from the natural ſocket, if it be kept any time it will not adhere; it has become a dead part, and the living ſubſtance refuſes to unite with it. Again, and in oppoſition to this, is it not very extraordinary that a tooth may be burnt by chemical agents, or the actual cautery, down to the centre, and yet retain its hold; or that the body of the tooth may be cut off, and a new tooth fixed into it by a pivot? Had the teeth any vaſcular action, this torturing would cauſe re-action and diſeaſe in them. Sometimes the moſt terrible effects are produced by theſe operations, as tetanus, abſceſs in the jaws, &c.; but this happens in conſequence of the central nerve being bruiſed by the wedging of the pivot in the cavity of the tooth, or by the roots of the tooth becoming, as dead bodies, a ſource of irritation to the ſurrounding ſockets.

We may conclude that the teeth are peculiar in their ſubſtance and ſtructure, in the manner of their growth and nutrition; and, as they are diſtinct from the other bones of the ſyſtem in their form and connections, ſo are they peculiar in the degree of vitality they enjoy.

Of the gums.—The necks of the teeth are ſurrounded by the gums, a red, vaſcular, but firm ſubſtance, which covers the alveolar proceſſes. To the bone and to the teeth the gums adhere very ſtrongly, but the edge touching the tooth is looſe. The gums

have

have little fenfibility in their healthy and found ftate; and by maftication, when the teeth are loft, they gain a degree of hardnefs which proves almoft a fubftitute for the teeth. The ufe of the gum is chiefly to give firmnefs to the teeth, and at the fame time, to give them that kind of fupport which breaks the jar of bony contact. Like the alveolar procefs, the gums have a fecret connection with the ftate of the teeth. Before the milk-teeth appear, there is a firm ridge which runs along the gums *, but this is thrown off, or waftes with the rifing of the teeth: and as the teeth rife the proper gums grow, and embrace them firmly. The gum is firm, and in clofe adhefion, when the teeth are healthy; loofe, fpongy, or fhrunk, when they are difeafed. The only means of operating upon the general ftate of the teeth is through the gums; and by keeping them in a ftate of healthy action, by the brufh and tinctures, the dentift fixes the teeth, and preferves them healthy; but when they are allowed to be loofe and fpongy, and fubject to frequent bleeding, (which is improperly called a fcorbutic ftate,) the teeth become loofe, and the gums painful. If a healthy tooth be implanted in the jaw, the gum grows up around it, and adheres to it; but if it be dead or difeafed, the gum ulcerates, loofens, and fhrinks from it; and this fhrinking of the gums is foon followed by the abforption of the focket.

From the diforder of the teeth, the gums are fubject to many difeafes; fome of them troublefome, fome dangerous, or at leaft giving rife to dangerous difeafes. They fwell from tooth-ach and inflammation of the centre of the tooth (parulis), or form tumors from the fide of the tooth (epulis). Often fuppuration follows thefe fwellings; and the matter making its way by the fide of the jaw, and deftroying the alveoli, troublefome fiftulæ are the confequence. The accumulation of tartar on the teeth is the caufe of an ulceration and wafting of the gums, in the end very injurious to the teeth. The foft, fpongy, and bleeding tumors which

* See Heriffant.

arife

arife from the gums, are in fact difeafes of the bone, or rather the peculiar characteriftic of the difeafe of the alveoli, and of the cancelli of the jaw-bone; and cannot be cured but by a practice which reaches to the root and origin of the difeafe.

OF THE FIRST AND SECOND SET OF THE TEETH.

Before we obferve the claffing of the adult teeth, we muft attend to the two fets of teeth, the infantine or deciduous teeth, and the adult or permanent teeth.

The firft fet of teeth are twenty in number: thefe are divided into three claffes; the INCISORES, four in each jaw; the CUSPIDATI, two in each jaw; and the MOLARES, four in number in each jaw.

The teeth of a child generally appear in this order: firft the central incifores of the lower jaw pierce the gum. In a month after, perhaps, their counterparts appear in the upper jaw. Thefe, in a few weeks are fucceeded by the lateral incifores of the lower jaw; then the lateral incifores of the upper jaw, though fometimes the lateral incifores of the upper jaw appear before thofe of the lower jaw. The growth of the teeth is not after this in a regular progreffion backwards, for now, inftead of the cufpidati, which are immediately lateral to the incifores, the anterior molares of the lower jaw fhow their white furface above the gum about the fourteenth or fifteenth month. Now the cufpidati pierce the gum; and, laftly, the larger molares make their appearance, the teeth of the lower jaw preceding thofe above. The laft tooth does not rife till the beginning of the third year.

The teeth do not always cut the gum in this order; but it is the more regular and common order. When the teeth appear in irregular fucceffion, more irritation and pain, and more of thofe fymptoms which are ufually attributed to teething, are faid to accompany them.

The deciduous fet of teeth terminates with the rifing of the fecond molaris; for the third molaris being formed about

about the eighth year, when the jaw is advanced towards its perfect form, is not ſhed, but is truly the firſt permanent tooth. The molares of the adult are properly the permanent teeth (IMMUTABILES), for they alone ariſe in this part of the jaw, and remain in their original places; yet we muſt recollect that, in oppoſition to Albinus, in this arrangement, it is more common to ſpeak of the whole ſet of the adult teeth as the *immutabiles*.

In the ſixth and ſeventh years the jaws have ſo much enlarged, that the firſt ſet of teeth ſeems too ſmall, ſpaces are left betwixt them, and they begin to fall out, giving place to the adult teeth. But the ſhedding of the teeth is by no means regular in regard to time; the child is already no longer in a ſtate of nature, and a thouſand circumſtances have ſecretly affected the health and growth. The teeth even fall out three years earlier in one child than in another: nay, ſo frequently are ſome of them retained altogether, that it would appear neceſſary to be aſſured of the forward ſtate of the adult tooth before the tooth of the firſt ſet ſhould be thoughtleſsly drawn.

The jaw-bones are ſtill ſo ſmall, that the ſecond ſet of teeth muſt riſe ſlowly and in ſucceſſion, elſe they would be crowded into too ſmall a circle, and of courſe turned from their proper direction.

The inciſores of the under jaw are looſe commonly when the anterior of the permanent molares are thruſting up the gum. The permanent central inciſores ſoon after appear, and in two or three months more thoſe of the upper jaw appear. In three or four months the lateral inciſores of the lower jaw are looſe, and the permanent teeth appear at the ſame time with the anterior molares. The lateral inciſores of the upper jaw follow next; and in from ſix to twelve months more, the temporary molares looſen, the long fangs of the cuſpidati retaining their hold ſome time longer.

The anterior molaris and the cuſpidati falling, are ſucceeded about the ninth year by the ſecond of the bicuſpides and the cuſpidati. The poſterior of the bicuſpides

take

take the place of the anterior of the molares about the tenth or eleventh year. The ſecond permanent molares do not appear for five or ſix years from the commencement of the appearance of the permanent teeth. The laſt of the molares, or the dens ſapientiæ, appears from the fifteenth to the twentieth, or even to the twenty-fifth year.

CLASSES OF THE ADULT TEETH.

The teeth at full maturity are thirty-two in number *, and they are divided into theſe claſſes, *inciſores*, *cuſpidati*, *bicuſpides*, and *molares*.

The inciſores are eight in number, four in each jaw: they are of the ſimpleſt form, their edges are even, and laterally they contract equally to the neck: they are gibbous, forward, and ſlightly concave on the inſide; their roots are ſimple. The inciſores of the upper jaw are larger and ſtronger; thoſe of the lower jaw are ſmaller, neater, and for the moſt part evenly ſet, while the teeth of the upper jaw are more frequently irregular from their greater ſize, and their being crowded together.

The cuſpidati † are four in number, one lateral to the inciſores of each jaw. They are ſtronger than the laſt in their form; thicker at the baſe in the gum; more convex forward, and terminate with a notched central point. They are called the canine teeth. The canine tooth in man riſes a very little above the level of the other teeth, ſo that it does not prevent the lateral or grinding motion. In carnivorous animals it projects, and a ſpace is left for it in the oppoſite jaw. This form of the canine teeth locks the jaws when the teeth are cloſed, ſo that there can be no lateral motion. In brutes having *tuſks* they are turned out of the mouth; they are not for taking prey, but procuring roots and ſuch kind of food, though at the ſame time, formidable weapons of defence; the poſition of the tuſk does not interfere with the lateral motion of the jaw, nor intercept maſtication.

* From twenty-eight to thirty-two in number.—Hunter.

† *Dentes canini*, or the eye teeth, from their place of original lodgment in the upper jaw.

Next

Next in order from the ſymphyſis of the jaw riſe the bicuſpides, the fourth and fifth teeth. Theſe are eight in number, and accurately reſemble each other. Taking one, we may obſerve that it is flattened laterally, anſwering to the flat ſide of the root, and that the crown terminates in two acute points: the internal of theſe points, even when not worn down, is the leaſt. The ſecond bicuſpis is often wanting. The bicuſpides are very often called the anterior grinders. Their roots are ſingle, or appear like two fangs united; or the firſt bicuſpis has in general two ſmall fangs, or is rather forked; the others ſeldom more than one. Their roots are oftener curved than thoſe of the other teeth.

The firſt and ſecond grinders are nearly alike. The body of theſe forms almoſt a ſquare; generally five points project from their grinding ſurface, which makes an irregular cavity in the centre: often ſome leſſer tubercles, or points, are to be obſerved at the baſe of the larger ones. The neck of the tooth is but little contracted. There are two fangs, one foreward, the other backward, with their edges turned outward; their extremities are broad, often bifurcated, and ſhorter than thoſe of the bicuſpides. There are two cavities to each fang leading to the general cavity in the body of the tooth. The fangs at their middle part are generally bent a little backward. The upper grinders have three diverging fangs, and they are more pointed, and have but one canal. They are directly under the floor of the maxillary ſinus.

The jaw acquires its full proportion about the age of eighteen or twenty, when the third molaris, or the *dens ſapientiæ*, makes its appearance. This tooth is ſhorter and ſmaller, and is inclined more inward than the others. Its fangs are leſs regular and diſtinct, being often ſqueezed together. From the cuſpidati to the laſt grinder, the fangs are becoming much ſhorter; and from the firſt inciſor to the laſt grinder, the teeth ſtand leſs out from the ſockets and gums.

BOOK

BOOK II.

OF THE MUSCLES.

CHAP. I.

MUSCLES OF THE FACE, EYE, AND EAR.

I. MUSCLES OF THE FACE.

THE OCCIPITO FRONTALIS is a broad and thin mufcular expanfion, which covers all the upper part of the cranium. It confifts of two bellies, with an intermediate fheet of flat tendon. The one belly covers the occiput, the other covers the forehead, and the tendinous expanfion covers all the upper part of the head; by which it has happened that the moft eminent anatomifts, as Cowper (p. 29.) have mifnamed its tendon, pericranium; many have reckoned it two diftinct mufcles, viz. the OCCIPITAL and FRONTAL, while others (becaufe of a fort of rapha, or line of divifion in the middle of each belly), have defcribed four mufcles, viz. two frontal, and two occipital mufcles. But it is truly a double bellied mufcle; and the broad thin tendon, which belongs equally to both bellies, lies above the true pericranium, and flides upon it. The mufcle is therefore named, with ftrict propriety, occipito-frontalis, fometimes EPICRANIUS, fometimes BIVENTER, or DIGASTRICUS CAPITIS.

ORIGIN.—The occipital portion is the fixed point of this mufcle arifing from the upper ridge of the occipital bone, and covering the back part of the head, from the maftoid procefs of one fide, round to that on the oppofite fide of the head. And by the perpendi-

cular

cular ridge of the occiput, it is marked with a flight divifion in the middle.

INSERTION. — The fore belly of the mufcle which covers the forehead, is fixed more into the fkin and eye-brows than into the bone : it is flightly attached to the bone, near the inner end of the orbitary ridge, and efpecially about the inner corner of the eye, and the root of the nofe, by a fmaller and acute pointed procefs ; but ftill its chief attachment is to the eye-lids and fkin.

The TENDON or thin MEMBRANEOUS expanfion which joins the two bellies, is exceedingly thin : it has on its inner fide, much loofe cellular fubftance, by which, though attached to the true pericranium, it flides eafily and fmoothly upon it ; but its outer furface is fo firmly attached to the fkin, and its fore belly adheres fo firmly to the eye-brows, that it is very difficult to diffect it clean and fair.

I confider the occipital belly as the fixed point, having a firm origin from the ridge of the bone ; its frontal belly has the loofe end attached, not to the os frontis, but to the eye-brow and fkin, and its office, that of raifing the eye-brows, wrinkling the forehead, and corrugating the whole of the hairy fcalp, like that mufcle under the fkins of animals, which fhrinks when they are cold or rudely touched, and by which they fhake off flies or infects. But it is a mufcle more employed in expreffing paffions, than in performing ufeful motions, and it is often fo thin, as hardly to be perceived. In fome it is entirely wanting, and many who have the mufcle, have no command nor power over it.

There is a fmall, neat, and pointed flip of the occipito frontalis, which goes down with a peak towards the nofe, and is inferted into the fmall nafal bone. This procefs, being much below the end of the eye-brow, muft pull it downwards ; fo that while the great mufcle raifes the eye-brow and fkin of the forehead, this fmall nafal flip pulls the eye-brow downwards again, reftoring it to its place, and fmoothing the fkin. It may be con-

fidered

ſidered as the antagoniſt of the great occipital and frontal bellies, and might almoſt be deſcribed as a diſtinct muſcle.

II. The CORRUGATOR SUPERCILII is another ſlip which might be fairly enough referred, like this, to the occipital muſcle; but being in many ſubjects particularly ſtrong, it is beſt deſcribed as diſtinct *. The lower end of the naſal ſlip of the occipito frontalis is fixed to the naſal bone. The lower end of the little ſlip, the corrugator ſupercilii, is fixed into the internal angular proceſs; and from the inner angle of the eye, the fibres ſweep round the edge of the orbit, and going obliquely upwards and outwards, are ſo mixed with the fibres of the frontal muſcle, and of the orbicularis oculi, where theſe two touch each other, that it is doubtful to which of theſe greater muſcles this little one might be moſt properly referred. So this ſlip of oblique fibres, riſing from the inner angle of the eye, and being fixed into the eye-brow, alſo antagonizes the occipito frontalis, and drawing the eye-brows together, and wrinkling the ſpace betwixt them, is very rightly named CORRUGATOR SUPERCILII.

III. ORBICULARIS OCULI, or PALPEBRARUM, is a neat and regular muſcle, ſurrounding the eye, and covering the eye-lids in a circular form. It is exceedingly flat and thin; is about an inch in breadth; lies immediately under the ſkin of the eye-lids, and is immediately attached to them, and but little connected with the bone. It has one ſmall tendon in the inner corner of the eye, which is both its origin and inſertion; for it begins and ends in it. This ſmall tendon is eaſily felt through the ſkin in the inner corner of the eye. It ariſes by a little white knot from the naſal proceſs of the upper jaw-bone. Its fibres immediately become muſcular, and ſpread out thin over the upper eye-lid. They paſs over it to the outer corner of the eye, where they croſs a little, and having covered juſt the edge of the temple with their thin expanded fibres, they

* It lies entirely under the frontal muſcle: it is firmer and ſmoother in its fibres. C. B.

they return in a circular form round by the lower eye-lid to the point from whence they had ſet out. This is, in all its courſe, a very thin muſcular expanſion, with regular orbicular fibres. It is rather a little broader over the lower eye-lid, extends itſelf a little upon the face beyond the brim of the ſocket, both at the temple, and upon the cheek; and its fibres croſs each other a little at the outer angle; ſo that ſome, underſtanding this croſſing as a meeting of fibres from the upper and from the lower muſcle, have deſcribed it as two ſemicircular muſcles. And thoſe fibres which are next to the tarſus or cartilaginous circle of the eye-lids, were diſtinguiſhed by Riolan, under the title of MUSCULUS CILIARIS. Our name expreſſes the common opinion, that it is a circular muſcle, whoſe chief point or fulcrum is in the inner corner of the eye, and which ſerves as a ſphincter for cloſing the eye. It ſqueezes with ſpaſmodic violence, when the eye is injured, as by duſt. And by its drawing down the eye-lids ſo firmly, it preſſes up the ball of the eye hard into the ſocket, and forces, the lachrymal gland that is within the ſocket, ſo as to procure a flow of tears.

IV. LEVATOR PALPEBRÆ SUPERIORIS.—This ſmall muſcle ariſes deep within the ſocket, from the margin of that hole which gives paſſage to the optic nerve. It begins by a ſmall flat tendon in the bottom of the optic cavity, becomes gradually broader as it goes over the eye-ball; it ends in the eye-lid, by a broad expanſion of muſcular fibres, which finally terminate in a ſhort flat tendon. It lies under the orbicularis palpebræ, is inſerted into the whole length of the cartilage of the tarſus, and raiſes and opens the upper eye-lid. And the diviſion of the orbicularis oculi into two, by the older anatomiſts, was a conſequence of their not knowing of the true levator palpebræ, and their not being able to deſcribe any muſcle by which the upper eye-lid could be raiſed, except the upper half of the orbicularis.

The occipito frontalis, but eſpecially its occipital belly, raiſes the eye-brows; the pointed ſlip of the ſame muſcle pulls them downwards; the corrugator pulls

them

them directly inwards, and knits the brows; the levator palpebræ opens the eye-lid, and the orbicularis oculi closes the eye. Whether certain fibres from the platisma-myoides, (a thin flat muscle which mounts from the neck, over the cheek,) may not pull down the lower eye-lid, or whether some straggling fibres, arising from the zygoma, may not have the appearance of a depressor of the lower eye-lid, it is not necessary to determine, since there is no regularly appointed muscle, and the lower eye-lid is almost immovable, at least in man.

MUSCLES OF THE NOSE AND MOUTH.

V. LEVATOR LABII SUPERIORIS and ALÆ NASI. Cowper describes the levator labii superioris as an irregular production of the frontalis, extending along the nostrils. But it is a neat and delicate muscle, which arises, by a small double tendon, from the nasal process of the upper jaw-bone, close by the tendon of the orbicularis oculi. It is one little fasciculus of muscular fibres above; but as it approaches the nose, it spreads out broader, dividing into two small fasciculi, one of which is implanted into the wing or cartilage of the nose, and the other, passing the angle of the nose, goes to the upper lip: thus it is pyramidal with its base downwards, and was named pyramidalis by Casserius, Winslow, and others. It is called by Cowper dilator alæ nasi; it raises the upper lip, and spreads the nostrils wide, as is observed in a paroxysm of rage, or in asthmatics.

VI. The levator labii superioris proprius, is distinguished by the name of levator proprius, because there are two others; one belonging to the angle of the mouth, and consequently to both lips; and one common to the lip and nostril.

The levator proprius is often named musculus incivus, beause it arises from the upper jaw, just above the incisores, or cutting teeth, and consequently just under the edge of the orbit: it is broad at its origin; it lies flat, and runs downwards, and obliquely inwards,

 to

to the middle of the lip, till it meets its fellow juſt in the filtrum*. It pulls the upper lip and the ſeptum of the noſe directly upwards.

VII. The LEVATOR ANGULI ORIS, is called alſo LEVATOR COMMUNIS LABIORUM, becauſe it operates equally on both lips. It is named CANINUS; for as the laſt-named muſcle riſes from the upper jaw-bone above the inciſores or cutting teeth, this ariſes above the canini or dog teeth, or above the firſt grinder, by a very ſhort double tendon. The exact place of its origin is half way betwixt the firſt grinder and the infra orbitary hole: it is mixed with the orbicularis oris, at the corner of the mouth, ſo that it raiſes the angle of the mouth upwards.

VIII. The ZYGOMATICUS MAJOR has nearly the ſame direction and uſe with this one: for it ariſes from the cheek bone near the zygomatic ſuture; runs downwards and inwards to the corner of the mouth; is a long and ſlender muſcle, which ends by mixing its fibres with the orbicularis oris and the depreſſor of the lip.

IX. The ZYGOMATICUS MINOR ariſes a little higher upon the cheek bone, but nearer the noſe; it is much ſlenderer than the laſt, and is often wanting.

It is the zygomatic muſcle that marks the face with that line which extends from the cheek bone to the corner of the mouth, and which is ſo ſtrong in many. The zygomatic muſcles pull the angles of the mouth upwards as in laughter; or one of them diſtorts the mouth, whence the zygomatic muſcle has gotten the name of diſtortor oris; the ſtrong action of the muſcle is particularly ſeen in laughter, rage, grinning.

X. BUCCINATOR. The buccinator was long thought to be a muſcle of the lower jaw, ariſing from the upper alveoli, and inſerted into the lower alveoli to pull the jaw upwards; but its origin and inſertion, and the direction of its fibres, are quite the reverſe of this. For this large flat muſcle, which forms, in a manner, the

* The filtrum is the ſuperficial gutter along the upper lip from the partition of the noſe to the tip of the lip.

walls

walls of the cheek, arifes chiefly from the coronoid procefs of the lower jaw-bone, and partly alfo from the end of the alveoli or focket procefs of the upper jaw, clofe by the pteregoid procefs of the fphenoid bone; it arifes alfo from the upper jaw; it goes forwards with direct fibres to be implanted into the corner of the mouth; it is thin and flat, and forms the walls of the cheek; it is perforated in the middle of the cheek by the duct of the parotid gland. Thefe are its principal ufes; that it flattens the cheek, and fo affifts in fwallowing liquids: that it turns, or helps to turn, the morfel in the mouth while chewing, and prevents it getting without the line of the teeth: in blowing wind inftruments, it both receives and expels the wind: it dilates like a bag, fo as to receive the wind in the cheeks; and it contracts upon the wind, fo as to expel the wind, and to fwell the note: In blowing the ftrong wind inftruments, we cannot blow from the lungs, for it ftreffes the breathing, but referve the air in the mouth, which we keep continually full; and from this it is named, from blowing the trumpet, the BUCCINATOR.

XI. DEPRESSOR ANGULI ORIS.—The depreffor anguli oris is a neat fmall triangular mufcle, and is indeed very commonly named MUSCULUS TRIANGULARIS LABIORUM, from its fhape. The bafe of the triangle is at the line of the lower jaw, where the mufcle rifes with a fat flefhy head about an inch in breadth. It grows fmaller gradually as it rifes towards the corner of the mouth, where it is implanted, fmall almoft in a point, and directly oppofite to the zygomatic and levator mufcles; and as the zygomatic mufcle makes a line from the cheek down to the angle of the mouth, this makes a line from the chin up to the corner of the mouth. It is chiefly active in expreffing the paffions, and gives form to the chin and mouth. In cheerful motions, as laughter, fmiling, &c., the zygomatics and levators pull the angles of the mouth upwards. In fear, hatred, revenge, contempt, and the angry paffions, the triangulares pull the corners of the mouth downwards; and, at the place where

where theſe meet, there is formed a ſort of riſing at the angle of the mouth: for a great many tendons are crowded into this one point; the zygomatic, levator, depreſſor, and orbicularis oris muſcles meeting and croſſing each other at this place.

XII. The DEPRESSOR LABII INFERIORIS is a ſmall muſcle, the diſcovery of which Cowper claims for himſelf. It is a ſmall muſcle, lying on each ſide of the chin, which, with its fellow, reſembles very much the levators of the upper lip. The depreſſor labii inferioris ariſes on each ſide of the chin, from the lower jaw-bone, under the line of the triangular muſcle. It goes obliquely upwards and inwards, till it meets its fellow in the middle of the lip; and where the muſcles of the oppoſite ſide meet, there is a little filtrum or furrow on the lower lip, as on the upper one. It mixes its fibres with the orbicularis, and its uſe is to pull the lip downwards: each muſcle is of a ſquare form, and thence has been often named QUADRATUS GENÆ, the ſquare muſcle of the chin.

XIII. The ORBICULARIS ORIS, or muſcle round the mouth, is often named CONSTRICTOR ORIS, SPHINCTER or OSCULATOR. It is very regular; it is an inch in breadth, and conſtitutes the thickneſs of the lips: it lies in the red part of the lips, and is of a circular form ſurrounding the mouth after the ſame manner that the orbicularis oculi encircles the eye. We ſee a degree of croſſing in the fibres at the angles of the mouth, whence it has been conſidered by many, not as a circular muſcle, but as one conſiſting of two ſemicircular muſcles, the SEMI ORBICULARIS ſuperior, and SEMI ORBICULARIS INFERIOR. Its fixed points are the two angles of the mouth; at that ſwelling which is formed by the union of the zygomatic, triangular, and other muſcles, part of it takes origin from the alveolar proceſs of the canine teeth. The chief uſe of this muſcle is to contract the mouth, and antagonize the other muſcles which I have juſt deſcribed. Often a ſmall ſlip runs up from the middle of the upper lip, to the tip of the noſe; it is the NASALIS LABII SUPERIORIS of Albinus; it lies exactly

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in the furrow of the filtrum, and is occasionally a levator of the upper lip, or a depressor of the tip of the nose.

These muscles of the nose and lips, are not useful merely in expressing the passions; that is but a secondary and accidental use, while their great office is to perform those continual movements, which breathing, speaking, chewing, swallowing, require. There are muscles for opening the mouth in various directions, which are all antagonized by this one, the orbicularis oris. The levator labii superioris, and the depressor labii inferioris, separate the lips and open the mouth. The levator anguli oris, along with the zygomatic muscles, raises the cheek, and dilates the corners of the mouth. The buccinator pulls the corner of the mouth directly backwards, opening the mouth. The angularis oris also dilates the mouth, pulls the angles of the mouth downwards and backwards, and forms it into a circle, if the others act at the same time; but the orbicularis oris is the largest and strongest (formed as it were, by the fibres of all these, taking a new direction, and turning round the lips), shuts the mouth, and antagonizes them all, and from an opening as wide as the mouth can require, shuts the mouth at pleasure, so closely, as to retain the very breath against all the force of the lungs. It is the true antagonist of all the other muscles, and they and the orbicularis, mutually re-act on each other, in alternately opening and closing the mouth. This phenomenon of the orbicularis muscle, dilating to such a wideness, and in an instant closing the mouth again, with such perfect accuracy, as to retain the breath, puts to nought all the vain calculations about the contraction of muscles, as that they can contract no more than one third of their length; for here is an infinite contraction, such as no process can measure. It is a paralysis of these muscles that so often occasions a hideous distortion of the face; for when the one side of the body falls into palsy, the muscles of one cheek cease to act; the muscles of the other cheek continue to act with their usual degree of power. This contraction of the muscles of

of one cheek, excites alſo the orbicularis oris to act, and ſo the mouth is purſed up, and the lips and angles of the mouth are drawn towards one ſide.

There are ſome ſmaller muſcles, which, lying under theſe, could not be deſcribed without danger of confuſion; as—

XIV. The DEPRESSOR LABII SUPERIORIS and ALÆ NASI, which is very ſmall, and lies concealed under the other muſcles. It riſes from the gum or ſocket of the fore teeth, and thence is named by Winſlow, inciſicivus medius. It goes into the root of the noſtril and pulls it, and of courſe, the upper lip down, and is named by Albinus and Cowper, conſtrictor vel compreſſor alæ naſi.

XV. The CONSTRICTOR NASI, or compreſſer of the noſe, is a ſmall ſcattered bundle of muſcular fibres, which croſſes the wings, and goes to the very point of the noſe; for one ariſes from the wing of the noſe on each ſide, and meets its fellow in the middle ridge, where both are fixed into the middle cartilage, or into the lower point of the NASAL bones meeting with the peak of the frontal muſcle, or its ſcattered fibres. But this muſcle is ſo difficultly found, that when Cowper ſaw it diſtinctly marked in Bidloe's 12th table, he conſidered it as a fiction, having ſought for it very carefully, but in vain.

And XVI. The LEVATOR MENTI, which ariſes from the lower jaw, at the root of the cutting tooth, has been named INCISIVUS INFERIOR. It is inſerted into the ſkin, on the very centre of the chin: by its contraction it draws the centre of the chin into a dimple; and from its moving the under lip at the ſame time, it is named LEVATOR LABII INFERIORIS.

MUSCLES OF THE EXTERNAL EAR.

THOUGH perhaps not one of ten thouſand has the power of moving the outward ear, yet there are many thin and ſcattered fibres of muſcles about the root of the cartilage of the ear, to which we cannot refuſe the name and diſtinction of muſcles; and which ſerve, indeed,

deed, to indicate, that nature had intended a degree of motion, which, perhaps by the manner of covering the heads of children, we may have loſt. But in a few, theſe faſciculi of fibres, have not the form only, but the uſes of muſcles. The celebrated Mr. Mery, was wont, when lecturing on this ſubject, to amuſe his pupils, ſaying, pleaſantly, "that in one thing, he ſurely belonged to the long ear'd tribe;" upon which, he moved his ears very rapidly, backwards and forwards *.

XVII. SUPERIOR AURIS is named attollens becauſe it lifts the ear upwards: it is a very thin, flat expanſion, which can hardly be diſtinguiſhed from the faſcia of the temporal muſcle, upon which it lies; it ariſes broad and circular, from the expanded tendon of the occipito frontalis; and is inſerted narrow into the root of the cartilaginous tube of the ear.

XVIII. ANTERIOR AURIS is a very delicate, thin, and narrow expanſion, ariſing about the zygoma, or rather from the faſcia, with which the zygoma is covered; it is implanted round the cartilaginous tube at its root.

XIX. The POSTERIOR AURIS is alſo a ſmall muſcle, very delicate and thin; but the anterior riſes in one ſmall and narrow ſlip only, while this, the poſterior, riſes commonly, in three narrow and diſtinct ſlips, from about the place of the maſtoid proceſs †; whence it is often named TRICEPS AURIS. It goes directly forwards to be implanted into the concha. It is named RETRAHENS AURIS from its office.

But there are ſtill other muſcles enumerated, which are not for moving the outward ear upon the head, but for moving, or rather giving tenſion to the cartilages of the outward ear. Thoſe fibres, are merely muſcular membranes, which have none of the marks nor offices of true muſcles; they have ſeldom fleſhy fibres, and the parts upon which they lie are fixed. Heiſter denies them the title of muſcles, and calls them muſcular membranes only.

The ring and other bendings of the outward ear,

* Vide Palfin, who was his pupil. The celebrated Albinus could move his ears.

† Fibræ carneæ tranſverſæ, a nobis deſcriptæ. VALSALVA.

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are called helix and antihelix, tragus and antitragus; and this determines the names of theſe ambiguous fibres, which are ſometimes found lying upon theſe circles of the outward cartilage, juſt under the ſkin.

XX. The MUSCULUS HELICIS MAJOR lies upon the upper, or ſharp point of the helix, or outward ring.

XXI. HELICIS MINOR riſes lower than the former, upon the fore part of the helix.

XXII. The TRAGICUS lying upon the concha, and ſtretching to the tragus.

XXIII. The ANTITRAGICUS lies in the antitragus.

XXIV. And, laſtly, There is the TRANSVERSUS AURIS of Albinus.

MUSCLES OF THE EYE-BALL.

The eye-ball is entirely ſurrounded by muſcles, which turn it in all directions. There is one muſcle on either ſide, one above, and one below; theſe ariſe from the very bottom of the ſocket, ſpread out upon the ball of the eye, and are implanted into its forepart, where the expanſions of their colourleſs tendons form what is called the white of the eye. Now theſe four muſcles, coming the ſtraight courſe from the optic foramen to the anterior part of the eye-ball are called the recti, or ſtraight muſcles: for their pulling is from the bottom of the ſocket. But there are two other muſcles which are named the oblique muſcles, becauſe they pull from the edges of the ſocket, and turn the eye obliquely; for they go in a direction exactly oppoſite to the recti. The recti come directly forwards, from the bottom of the orbit; theſe go obliquely backwards, from the edge of the orbit; one riſes from the lower edge of the ſocket, and goes backwards under the eye-ball; the other riſes indeed, along with the recti, in the bottom of the ſocket, but it has a cartilaginous pulley on the very edge of the ſocket, at its upper part; and its ſmall round tendon firſt runs through this pulley, and then turns down upon the eye, and goes backwards; ſo that the ſtraight muſcles, preſs down the eye-ball deep into the ſocket, while the oblique

mufcles, bring the eye-ball forwards, pulling it outwards from the focket.

The trueft defcription of the recti, is as of one mufcle, fince their only variety is that difference of place, which is expreffed by the name of each. They all agree in thefe chief circumftances, that they arife by flat, but fmall tendons, round the margin of the optic hole, arifing from the circle of that hole, or rather from the periofteum there; and there being one above, one below, and one on either fide, they completely furround the optic nerve, and adhere to it. They are neat and delicate mufcles, which gradually expand each into a flefhy belly, which furrounds and covers the middle of the ball of the eye. They ftill go on expanding, till they at laft terminate, each in a broad, flat, and very white tendon, which covers all the fore part of the eye, up to the circle of the lucid cornea or window; and their white and fhining tendons form that enamelled-like part, which lies without the coloured circle, and which is named the white of the eye, or the TUNICA ALBUGINEA, as if it were abfolutely a diftinct coat.

Now, the only difference in thefe ftraight mufcles, is in refpect of length; for the optic nerve enters the eye, not regularly in the centre, but a little towards the inner fide, fo that the rectus internus, or mufcle neareft the nofe, is a little fhorter. The rectus externus, or mufcle neareft to the temple, is a little longer: But the rectus fuperior, and the rectus inferior are of equal length. The ufes of thefe mufcles are exceedingly plain.

XXV. The RECTUS SUPERIOR, lifting the eye directly upwards, is named the MUSCULUS ATTOLLENS, the LEVATOR OCULI or SUPERBUS, as expreffive of haughtinefs and pride.

XXVI. And the RECTUS INFERIOR, which is directly oppofite to it, is named DEPRIMENS OCULI or HUMILIS, as expreffing modefty and fubmiffion.

XXVII. The RECTUS INTERNUS is called ADDUCENS, as carrying the eye towards the nofe, or BIBITORIUS, becaufe it directs the eye to the cup.

And

And (XXVIII.) the RECTUS EXTERNUS, the outer ſtraight muſcle, as it turns the eye away, is named ABDUCTOR OCULI, or INDIGNABUNDUS, expreſſing anger or ſcorn. Such is the effect of theſe muſcles, that when they act in ſucceſſion, they roll the eye; but if they act all at once, the power of each is balanced by the action of its oppoſite muſcle, and the eye is immovably fixed. So that ſometimes in our operations, when the couching needle approaches the eye, fear comes upon the patient, and the eye is fixed by a convulſive action, more firmly than it could be by the inſtruments, or by the finger; ſo that the ſpeculum oculi is after ſuch an accident of no uſe. The eye continues fixed, during all the operation, but it is fixed in a moſt dangerous way, by a power which we cannot controul, and which ſometimes, when our operation is for extracting one of the humours only, ſqueezes out the whole.

XXIX. The OBLIQUUS SUPERIOR ariſes along with the recti in the bottom of the eye above, and towards the inner ſide, directing its long tendon towards the inner angle of the eye; and there it paſſes its tendon through that pulley, whoſe hollow I have marked in deſcribing the os frontis, as under the ſuperciliary ridge, and near to the inner corner of the eye. It ariſes by a ſmall tendon like one of the recti; it goes over the upper part of the eye-ball, a long and ſlender muſcle, whence it is often named LONGISSIMUS OCULI, the longeſt muſcle of the eye. It forms a ſmall ſmooth round tendon, which paſſes through the ring of the cartilaginous pulley, which is in the margin of the ſocket. The pulley is above the eye, and projects farther than the moſt prominent part of the eye-ball, ſo that the tendon returns at an acute angle, and bends downwards before it can touch the eye-ball. And it not only returns backwards in a direction oppoſite to the recti muſcles, but it ſlips flat under the body of the rectus ſuperior, and is ſpread out under it upon the middle or behind the middle of the eye, viz. about half way betwixt

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the infertion of the rectus, and the entrance of the optic nerve.

XXX. The OBLIQUUS INFERIOR is, with equal propriety, named the mufculu breviffimus oculi. It is directly oppofite to the obliquus fuperior, in form, place, office, &c., for it arifes from the nafal procefs of the jawbone, in the lower edge of the orbit, at the inner corner of the eye: it is fhort, flat, and broad, with a ftrong flefhy belly: it goes obliquely backwards and outwards, lying under the ball of the eye; and it is inferted broad and flat into the ball, exactly oppofite to the infertion of the obliquus fuperior mufcle.

Thefe two mufcles roll the eye, whence they are named mufculi circumagentes, or amatorii. But they have ftill another important office, viz. fupporting the eye-ball, for the operation of its ftraight mufcles; for when the obliqui act, they pull the eye forwards, the ftraight mufcles refift, and the infertion of the oblique mufcles at the middle of the eye-ball becomes, as it were, a fixed point, a centre or axis round which the eye-ball turns under the operation of the recti mufcles. The conjoined effect of the oblique mufcles is to bring the eye-ball forwards from the focket, as in ftraining the eye to fee at fome diftant point. The particular effect of the upper oblique mufcle is not to bring the eye forward, but to roll the eye fo as to turn the pupil downwards, and towards the nofe. And the particular effect of the lower oblique mufcle is to reverfe this action, to turn the eye again upon its axis, and to direct the pupil upwards and outwards; but the fucceffive actions of all thefe mufcles move the eye in circles with gradations fo exquifitely fmall, and with fuch curious combinations as cannot be explained by words.

CHAP.

CHAP. II.

MUSCLES OF THE LOWER JAW, THROAT, AND TONGUE.

MUSCLES OF THE LOWER JAW.

THE lower jaw requires mufcles of great power to grind the food; and accordingly it is pulled upwards by the ftrong temporal, maffeter, and pteregoid mufcles; but in moving downwards, the jaw almoft falls by its own weight, and having little refiftance to overcome, any regular appointment of mufcles for pulling down the jaw, is fo little needed, that it is pulled downwards by mufcles of fuch ambiguous office, that they are equally employed in raifing the throat, or pulling down the jaw, fo that we hardly can determine to which they belong; for the chief mufcles of the throat, coming from the lower jaw, muft, when the jaw is fixed, pull up the throat, or when the throat is fixed, deprefs the jaw.

XXX. The TEMPORAL MUSCLE is the great mufcle of the jaw. It arifes from all the flat fide of the parietal bone, and from the fphenoid, temporal, and frontal bones, in that hollow behind the eye, where they meet to form the fquammous future. It arifes alfo from the inner furface of that ftrong tendinous membrane which is extended from the jugum to the femicircular ridge of the parietal bone. The fibres are bundled together and preffed into a fmall compafs, fo that they may pafs under the jugum: there they take a new hold upon the inner furface of the jugum; the mufcle is of courfe pyramidal, its rays converging towards the jugum; its mufcular fibres are intermixed with ftrong tendinous ones; it is particularly tendinous, where it paffes under the jugum; and it has both ftrength and protection from that tendinous plate which covers it in the temple. Its infertion is into the horn of the lower jaw-bone; not merely into the tip of the horn, but embracing it all round,

round, and down the whole length of the procefs, fo as to take the firmeft hold.

XXXI. The MASSETER is a fhort, thick, and flefhy mufcle, which gives the rounding of the cheek at its back part. It arifes from the upper jaw-bone, at the back of the antrum, and under the cheek-bone, and from the lower edge of the zygoma. It lies upon the outfide of the coronoid procefs, covering the branch of the lower jaw quite down to its angle. It is particularly ftrong, has many maffy bundles of flefh, interfperfed with tendinous ftrings; the parotid gland lies on its upper part, and the duct of the gland (as it croffes the cheek) lies over this mufcle. The jaw is very firmly pulled up by thefe two, which are its moft powerful mufcles; and when we bite, we can feel the temporal mufcle fwelling on the flat part of the temple, and this the maffeter upon the back part of the cheek.

XXXII. XXXIII. The two PTEREGOID MUSCLES (of which there are four in all, two on either fide) are named from their origin in the pteregoid proceffes of the fphenoid bone. The PTEREGOIDEUS INTERNUS is that one which rifes from the internal or flatter pteregoid procefs, and which goes downwards and outwards to the angle of the jaw on its infide. The PTEREGOIDEUS EXTERNUS arifes from the external pteregoid procefs, and goes not downwards, but almoft directly outwards, and is implanted high in the jaw bone, juft under its neck, and connected with its capfular ligament. Now the pteregoideus internus defcending to be fixed to the angle of the jaw, is longer and bigger, and is named PTEREGOIDEUS MAJOR. The external one going directly acrofs, and rather backwards, has lefs fpace to traverfe, is fhorter, and is named PTEREGOIDEUS MINOR.

The jaw is moved chiefly by thefe mufcles; the temporalis acting upon the coronoid procefs like a lever, the maffeter acting upon the angle, and before it, and the pteregoideus internus balancing it within, like an internal maffeter fixed to the infide of the angle. All thefe pull ftrongly upwards for biting, holding, and tearing,

tearing with the teeth; and the external or leffer pteregoid mufcle going from within outwards, pulls the jaw from fide to fide, and performs the motion of grinding.

MUSCLES OF THE THROAT AND TONGUE.

The MUSCLES of the THROAT and TONGUE cannot be underftood without a previous acquaintance with certain cartilages and bones, which form the bafis of the throat and tongue, and the centre of thofe motions which we have next to defcribe.

The OS HYOIDES is a fmall bone refembling in fhape at leaft the lower jaw-bone. It has a middle thicker part, named its bafis, which is eafily felt outwardly; it correfponds in place with the chin, and during life it is diftinguifhed about an inch below the chin, the uppermoft of the hard points which are felt in the forepart of the throat. Next, it has two long horn-like proceffes, which go backwards along the fides of the throat, called the cornua, or horns of the os hyoides, and which are tied by a long ligament, to the ftyloid procefs of the temporal bone. And, laftly, it has fmall cartilaginous pieces or joinings, by which the horns are united to the bafis; and often in the adult this joining is converted into bone. At this point, where the two horns go backwards, like the legs of the letter U, there are commonly, at the griftly part of the os hyoides, two fmall perpendicular proceffes which ftand up from the joining of the horns to the body, and thefe are named the appendices of the os hyoides or the leffer cornua.

Now, this os hyoides forms by its bafis the root of the tongue, thence it is often named the bone of the tongue. It forms at the fame time a part of the larynx, which is the collection of cartilages forming the top of the trachea, or windpipe; and it carries upon it that cartilage named epiglottis, which, like a valve, prevents any thing getting down into the windpipe. Its horns extend along the fides of the throat, keeping the openings of the windpipe and gullet extended, as we would

keep a bag extended by two fingers. The chief mufcles of the tongue and of the windpipe arife from its body; the chief mufcles of the gullet arife from its horns, and efpecially from their points; it receives the chief mufcles which either raife or deprefs the throat; and it is the point d'appui, or fulcrum for all the mufcles of the throat and tongue, and the centre of all their motions. It is the centre of the motions of the tongue, for it is the origin of thefe mufcles which compofe chiefly the bulk of the tongue, of the motions of the trachea or windpipe, for it forms at once the top of the windpipe, and the root of the tongue, and joins them together; of the motions of the pharynx or gullet, for its horns furround the upper part of the gullet, and join it to the windpipe; and it forms the centre for all the motions of the throat in general: for mufcles come down from the chin to the os hyoides, to move the whole throat upwards; others come up from the fternum, to move the throat downwards; others come obliquely from the coracoid procefs of the fhoulder blade, to move the throat backwards, while the os hyoides ftill continues the centre of all thefe motions.

The TRACHEA, or WINDPIPE, is that tube which conveys the air to the lungs; and the larynx is the head or figured part of that tube which is formed like a flute for the modulation of the voice, and confifts of cartilages, that it may ftand firm and uncompreffed, either by the paffage of the food, or by the weight of the outward air; and that it might refift the contraction of the furrounding parts, ferving as a fulcrum for them in the motions of the jaw, tongue and gullet. Its cartilages are, firft, the SCUTIFORM, or THYROID cartilage, which is named from its refemblance to a fhield, or rather it is like the flood-gates, or folding doors of a canal, the meeting of the two fides being in the middle line of the throat. This prominent line of the thyroid cartilage is eafily felt in the middle of the throat, is about an inch in length, and makes that tumour which is called the pomum Adami. The flat fides of the thyroid cartilage form the fides of the flute-

part of the trachea. And there are two long horns at its two upper corners, which riſe like hooks above the line of the cartilage, and are joined to the horns of the os hyoides, and two ſimilar but ſhorter hooks below, by which it embraces the cricoid cartilage.

The CRICOID CARTILAGE is next to the thyroid, and below it; it is named from its reſemblance to a ring: It is indeed like a ring or hoop, but it is not a hoop equally deep in all its parts, it is ſhallow before, where it ekes out the length of the thyroid cartilage, and is deeper behind, where it forms the back of this flute-like top of the trachea; it is the top ring of the trachea, and the lower ring of the larynx or flute-part of the wind-pipe. And upon its back, or deeper part, are ſeated thoſe two ſmall cartilages, which, with their ligaments, form the opening for the breath.

The ARYTENOID CARTILAGES are two ſmall triangular bodies, ſeated within the protection of the thyroid cartilage. They are fooliſhly deſcribed with cornua ridges and ſurfaces, when they are ſo ſmall that nothing further can be obſerved of their forms, than that they are ſomewhat conical; that the baſe or broad part of each ſits down upon the upper edge of the cricoid cartilage at its back; that the point of each ſtands directly upwards, and is a very little crooked, or hook-like; that ſtanding, as they do, a little apart from each other, they form together an opening ſomething like the ſpout of a ewer, or ſtrouped baſon, whence their names. And theſe cartilages being covered with the common membrane of the throat, which is thick, and full of mucous glands, the opening gets a regular appearance with rounded lips. From theſe cartilages to the back part of the thyroid cartilages, ligaments are extended; over theſe ligaments the lining membrane of the larynx is laid, and betwixt the arytenoid ligaments is formed the chink or rima glottidis; viz. the opening of the windpipe. The voice is, in a conſiderable degree, formed by the motion of theſe cartilages and their ligaments, and the action of the muſcles of the arytenoid cartilages are ſo exquiſitely minute, that for every changing

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of the note (and there are fome thoufand gradations in the compafs of the voice,) they move in a proportioned degree.

The EPIGLOTTIS is a fifth cartilage of the trachea, belonging to it both by connection and by office. It is a broad triangular cartilage, not fo hard as the others, very elaftic, and fo exactly like an artichoke leaf, that no other figure can reprefent it fo well. Its office is to defend the opening of the glottis. It is fixed at once to the os hyoides, to the thyroid cartilage, and to the root of the tongue, and it hangs obliquely backwards over the opening of the rima, or chink of the glottis; it is fufpended by little peaks of the membrane, which we call ligaments of the glottis, and it is faid to be raifed or depreffed by mufcles, which yet are not very fairly defcribed. But the rolling of the morfel which is fwallowed, and the motion of the tongue, are fufficient to lay it flat over the rima, fo that it is a perfect guard upon the windpipe.

Then this is the conftitution of the larynx. It is of hard cartilages to refift compreffion, and of a flute form at its opening, to regulate the voice. The THYROID cartilage is the great one, the chief defence before, and which has edges flanting far backwards, to defend the opening of the larynx. The CRICOID cartilage, which forms the upper ring of the trachea, fupports the arytenoid cartilages, and by its deepnefs behind raifes them fo, that the opening of the glottis is behind the middle of the great thyroid cartilage, and in the deepeft part of it, well defended by its projecting wings. The ARYTENOID cartilages form the rima glottidis, the chink by which we breathe; which, as it is narrower or wider, modulates and tunes the voice; the opening of which is fo exquifitely moved by its mufcles in finging, widening or contracting in moft delicate degrees, and which is fo fpafmodically fhut by the fame mufcles when it is touched by a drop of water, or by a crumb of bread; but the valve of the glottis, the EPIGLOTTIS ftanding over it, flaps down like the key of a wind inftrument, fo that the rarenefs of fuch accidents

is wonderful, when we conſider that the leaſt attempt to draw the breath, while we are ſwallowing, will produce the accident.

The muſcles which move the tongue and throat muſt be far too complicated to be explained at all, without ſome previous knowledge of theſe parts ; and ſtill, I fear, not eaſily to be explained with every help of regularity and order.

MUSCLES OF THE THROAT.

By this arrangement, I mean to include under one claſs, all thoſe muſcles which move the os hyoides, or the larynx, and through theſe, as centrical points, move the jaws, gullet, and tongue, and which, though they are inſerted into the larynx, have more relation to ſwallowing, or the motions of the gullet, than to breathing, or to the motions of the windpipe.

The muſcles which pull the throat down are theſe :

XXXIV. The STERNO-HYOIDEUS, which paſſes from the ſternum to the os hyoides, a flat broad ribband-like muſcle, which ariſes from the upper piece of the ſternum rather within the breaſt, and partly alſo from the clavicle and cartilage of the firſt rib, goes flat and ſmooth along the forepart of the throat, mounts nearly of the ſame breadth to the os hyoides, and is implanted into its baſis, or that part (which in reſembling the os hyoides to the jaw) we ſhould compare with the chin.

XXXV. The STERNO-THYROIDEUS, which paſſes in like manner from the ſternum to the thyroid cartilage, is like the laſt, a flat ſmooth ribband-like muſcle, rather thicker and more fleſhy, but very uniform in its thickneſs. As the thyroid cartilage is below the os hyoides, the ſterno-thyroid muſcle muſt lie under the ſterno-hyoideus muſcle. It ariſes under the ſterno-hyoideus muſcle from the ſternum and cartilage of the rib, and is implanted into the rough line of the lower edge of the thyroid cartilage, and a little to one ſide, but not ſo much as is repreſented in Cowper's drawings. It immediately covers the thyroid gland, and the operation of bronchotomy

bronchotomy is ſometimes performed by piercing the windpipe betwixt theſe two muſcles.

XXXVI. The OMO-HYOIDEUS, which was once named CORACO-HYOIDEUS, being thought to ariſe from the coracoid proceſs, is a muſcle of great length, and very ſlender; reaches from the ſhoulder to the os hyoides; it is like theſe laſt mentioned, a long flat ſtrap-like muſcle, as flat and as fleſhy, but not ſo broad as either of the former. It lies along the ſide of the neck; is pinched in a little in the middle, where it is divided by a tendinous croſs line, which ſeparates the fleſhy belly into two heads. It ariſes from the upper edge of the ſcapula, near its notch, and is implanted into the ſide of the os hyoides, where the horn goes off from the body of the bone.

Theſe three muſcles pull down the throat. The ſterno-hyoideus, and ſterno-thyroideus pull it directly downwards: one of the omo-hyoidei acting, pulls it to one ſide; but if both act, they aſſiſt in pulling directly down, and brace the trachea at the ſame time a little down to the back.

The muſcles which move the throat upward are:

XXXVII. The MYLO-HYOIDEUS, a flat and broad muſcle, which ariſes from the whole ſemicircle of the lower jaw, i. e. from the backmoſt grinders to the point of the chin. It riſes from the inner ſurface of the jaw-bone, goes down to the baſis of the os hyoides, proceeds with very regular, ſtraight, diſtinct, and orderly fibres, from the jaw to the os hyoides, is plainly divided in the middle from the ſymphyſis of the jaw to the middle of the os hyoides, by a middle tendinous and white line. And though Cowper denies the authority of Veſalius, who divides it thus, it is plainly two diſtinct muſcles, one belonging to either ſide.

XXXVIII. The GENIO-HYOIDEUS is a ſmall neat pair of muſcles ariſing from the chin at a rough point, which is eaſily diſtinguiſhed within the circle of the jaw. The mylo-hyoideus is named from the whole jaw. The genio-hyoideus is named from the chin, ariſing from a

ſmall tubercle behind the chin ; its beginning is exceed ingly narrow : as it proceeds downwards, it grows flat and broad ; it is implanted into the baſis of the os hyoides, by a broad edge, and is a beautiful and radiated muſcle. The ſublingual gland lies flat betwixt this muſcle and the laſt, and in the middle the ſublingual duct pierces the membrane of the mouth, to open under the root of the tongue. The two muſcles move the os hyoides forwards and upwards, when the jaw is fixed ; but when the os hyoides is fixed by the muſcles coming from the ſternum, theſe muſcles of the os hyoides pull down the jaw.

XXXIX. The STYLO-HYOIDEUS is one of three beautiful and ſlender muſcles, which come from round the ſtyloid proceſs, which all begin and end with ſlender tendons, and with ſmall fleſhy bellies ; and one going to the pharynx or gullet, another to the os hyoides, and a third to the tongue, they coincide in one common action of drawing back the tongue, and pulling the throat upwards.

This one the ſtylo-hyoideus, ariſes from about the middle of the ſtyloid proceſs, and going obliquely downwards and forwards, is fixed into the ſide of the os hyoides, where the baſis and horn are joined. Above its inſertion, its fibres are ſplit, ſo as to make a neat ſmall loop, through which the tendon of the digaſtric muſcle runs. This ſtylo-hyoideus is ſometimes accompanied with another ſmall fleſhy muſcle like it, and of the ſame name, which was firſt perhaps, obſerved by Cowper, and has been named by Innes, STYLO-HYOIDEUS ALTER ; but it is not regular, nor has it ever been acknowledged as a diſtinct muſcle.

XL. The DIGASTRICUS OR BIVENTER MAXILLÆ INFERIORIS muſcle, is named from its having two bellies. One belly ariſes from a rugged notch along the root of the maſtoid proceſs, where the fleſh is thick and ſtrong ; going obliquely forwards and downwards, it forms a long ſlender tendon, which paſſes by the ſide of the os hyoides ; and as it paſſes, it firſt ſlips through the loop or nooſe of the ſtylo-hyoideus, and then is fixed

fixed by a tendinous bridle, to the ſide of the os hyoides; and then turning upwards towards the chin, it ends in a ſecond fleſhy belly, which, like the firſt, is flat, and of a pyramidal ſhape, lying above the mylo-hyoideus.

Though this muſcle is often called biventer maxillæ inferioris, as belonging to the lower jaw, perhaps it does more regularly belong to the throat. No doubt, when the os hyoides is fixed by its own muſcles, from the ſhoulder and ſternum, the digaſtricus muſt act on the jaw; an office which we cannot doubt, ſince we often feel it taking a ſudden ſpaſm, pulling down the chin with ſevere pain, and diſtortion of the neck. But its chief office is raiſing the hyoides; for when the jaw is fixed, as in ſwallowing, the os hyoides pulls up the throat; and this is the true meaning of its paſſing through the nooſe of the ſtylo-hyoideus, and of its connection with the ſide of the os hyoides. Then the digaſtric and ſtylo-hyoideus muſcles, pull the throat upwards and backwards.

The muſcles which move the parts of the larynx upon each other, are much ſmaller, and many of them very minute.

XLI. The HYO-THYROIDEUS goes down, fleſhy and ſhort, from the os hyoides, to the thyroid cartilage. It ariſes from the lower border of the thyroid cartilage, where the ſterno-thyroideus terminates, and goes up along the ſide of the thyroid cartilage, like a continuation of the ſterno-thyroideus muſcle. It paſſes the upper border of the thyroid cartilage, and is fixed to the lower edge of the os hyoides, along both its baſe and part of its horn.

XLII. The CRICO-THYROIDEUS is a very ſhort muſcle, paſſing from the upper edge of the cricoid, to the lower margin of the thyroid cartilage, chiefly at its ſide, and partly attached to its lower horn, which comes down claſping the ſide of the CRICOID ring, ſo that it is broader above, and a little pointed below.

Theſe two ſmall muſcles muſt have their uſe, and they bring the thyroid cartilage nearer to the os hyoides, and

and the cricoid nearer to the thyroid cartilage ; and by thus ſhortening the trachea, or compreſſing it ſlightly, they may perhaps affect the voice ; but the muſcles on which the voice chiefly depends, are thoſe of the RIMA GLOTTIDIS; for there are many ſmall muſcles which have their attachment to the arytenoid cartilages, and which by their operation on the thyro-arytenoid ligament govern the rima glottidis.

XLIII. The MUSCULUS ARYTENOIDEUS TRANSVERSUS, is that delicate muſcle which contracts the glottis by drawing the arytenoid cartilages towards each other. It lies acroſs, betwixt them at their back part; it ariſes from the whole length of one arytenoid cartilage to go acroſs, and be inſerted into the whole length of the oppoſite one.

XLIV. ARYTENOIDEUS OBLIQUUS, is one which croſſes in a more oblique direction, ariſing at the root of each arytenoid cartilage, and going obliquely upwards to the point of the oppoſite one. Theſe two muſcles draw the arytenoid cartilages together, and cloſe the RIMA.

XLV. The CRICO-ARYTENOIDEUS POSTICUS, is a ſmall pyramidal muſcle, which ariſes broader from the back part of the cricoid cartilage, where the ring is broad and deep ; and going directly upwards, is implanted with a narrow point, into the back of the arytenoid cartilage. This pair of muſcles pulls the arytenoid cartilages directly backwards, and lengthens the ſlit of the glottis : perhaps they aſſiſt the former, in cloſing it more neatly, and in producing more delicate modulations of the voice.

XLVI. The CRICO-ARYTENOIDEUS OBLIQUUS, is one which comes from the ſides of the cricoid cartilage, where it lies under the wing of the thyroid, and being implanted into the ſides of the arytenoid cartilages, near their roots, muſt pull theſe cartilages aſunder, and (as the origin in the cricoid lies rather before their inſertion in the arytenoid cartilages) it muſt alſo ſlacken the lips of the ſlit ; for the lips of the ſlit are formed by two cords, which go within the covering membrane,

from

from the tip of each cartilage, to the back of the thyroid cartilage, and the crico arytenoideus posticus must stretch these cords, and the crico arytenoideus lateralis, must relax them.

XLVII. The THYREO ARYTENOIDEUS, is a muscle very like the last one, and assists it. It arises not from the cricoid cartilage, but from the back surface of the wing of the thyroid, from the hollow of its wing, or where it covers the cricoid; is implanted into the fore part of the arytenoid cartilage, and by pulling the cartilage forward and sideways, directly slackens the ligaments, and widens the glottis.

These are all the muscles which belong to the larynx; and in our arrangement, the muscles of the PALATE and PHARYNX come next in order.

When a morsel is to be thrown down into the œsophagus, or tube which leads to the stomach, the VELUM PALATI, or curtain of the palate, is drawn upwards; the opening of the throat is dilated; the morsel is received; then the curtain of the palate falls down again. The arch of the throat is contracted, the bag of the pharynx is compressed by its own muscles; and the food is forced downwards into the stomach.

XLVIII. The AZYGOS UVULÆ.—The VELUM PENDULUM PALATI is that pendulous curtain which we see hanging in the back part of the mouth, in a line with the side circles of the throat; and the uvula is a small pap, or point of flesh, in the centre of that curtain. The AZYGOS UVULÆ, or single muscle of the uvula, is a small slip of straight fibres, which goes directly down to the uvula in the centre of the curtain. It arises from the peak, or backmost sharp point of the palate bones, and pulls the uvula, or pap of the throat, directly upwards, removing it out of the way of the morsel which is to pass.

XLIX. LEVATOR PALATI MOLLIS arises from the point of the os petrosum, and from the EUSTACHIAN tube, and also from the sphenoid bone*. These parts hang

* From the Eustachian tube, it was named SALPINGO STAPHILINUS; from the sphenoid bone, SPHENO STAPHILINUS; from the pteregoid

hang over the roof of the velum, and are much higher than it; ſo this muſcle deſcends to the velum, and ſpreads out in it; and its office is to pull up the velum, to remove it from being in the way of the morſel, which is about to paſs, and to lay the curtain back at the ſame time, ſo as to be a valve for the noſtrils, and for the mouth of the Euſtachian tube, hindering the food or drink, from entering into theſe paſſages.

L. The CIRCUMFLEXUS PALATI *, and the conſtrictor iſthmi fauſcium, have a very different uſe. The circumflexus palati is named from its fibres paſſing over, or rather under the hook of the PTEREGOID proceſs; the muſcle ariſes along with the levator palati, (i. e.) from the ſphenoid bone at its ſpinous proceſs; and from the beginning of the Euſtachian tube, it runs down along the tube, in the hollow betwixt the pteregoid proceſſes; it then becomes tendinous, turns under the hook of the internal pteregoid proceſs, and mounts again to the ſide of the velum. Now, the levator and circumflexus ariſe from the ſame points; but the levator goes directly downwards into the velum, and ſo is uſeful in lifting it up. The circumflexus goes round the hook, runs on it as on a pulley, turns upwards again, and ſo it pulls down the palate, and ſtretches it, and thence is very commonly named, the TENSOR PALATI MOLLIS or ſtretcher of the palate.

LI. The CONSTRICTOR ISTHMI FAUSCIUM, ariſes from the very root of the tongue on each ſide, goes round to the middle of the velum, and ends near the uvula †.

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pteregoid proceſs, PTEREGO STAPHILINUS; from the petrous proceſs, it was named PETRO SALPINGO STAPHILINUS; as if there were no ſcience but where there were hard names, and as if the chief mark of genius were enriching the hardeſt names with all poſſible combinations and contortions of them.

* This alſo, has got a tolerable aſſortment of hard names, as CIRCUMFLEXIS PALATI, TENSOR PALATI, PALATO SALPINGEUS, STAPHELINUS EXTERNUS, SPHENO-SALPINGO-STAPHELINUS, MUSCULUS TUBÆ, viz. EUSTCHIANÆ NONUS. PTEREGO-STAPHILINUS of Cowper, &c.

† Named GLOSSO STAPHILINUS, from its origin in the tongue, and inſertion into the UVULA.

This

This ſemicircle forms that firſt arch which preſents itſelf, upon looking into the mouth.

LII. The PALATO-PHARYNGEUS * again, forms a ſecond arch behind the firſt; for it begins in the middle of the ſoft palate, goes round the entry of the fauces, ends in the wing or edge of the thyroid cartilage; and as the firſt arched line (that formed by the conſtrictor), belonged to the root of the tongue, the ſecond arched line belongs to the pharynx or gullet. The circumflexus palati makes the curtain of the palate tenſe, and pulls it downwards: the conſtrictor fauſcium helps to pull down the curtain, and raiſes the root of the tongue to meet it: the palato-pharyngeus farther contracts the arch of the fauces, which is almoſt ſhut upon the morſel now ready to be forced down into the ſtomach, by thoſe muſcles which compreſs the pharynx itſelf.

The PHARYNX, which is the opening of the gullet, that it may receive freely the morſel of food, is expanded into a large and capacious bag, which hangs from the baſis of the ſkull, is chiefly attached to the occipital bone, the pteregoid proceſſes, and the back parts of either jaw-bone. The œſophagus again, is the tube which conveys the food down into the ſtomach, and this bag of the pharynx is the expanded or trumpet-like end of it; or it may be compared with the mouth of a funnel. Towards the mouth, the pharynx is bounded by the root of the tongue, and by the arches of the throat; behind, it lies flat and ſmooth along the bodies of the vertebræ; before, it is protected, and in ſome degree ſurrounded by the great cartilages of the larynx; the horns of the os hyoides embrace its ſides, and it is covered with flat muſcular fibres, which, ariſing from the os hyoides and cartilages of the throat, go round the pharynx in fair and regular orders, and are named its conſtrictors, becauſe they

* The SALPINGO-PHARYNGEUS of Albinus, is no more than that part of the palato-pharyngeus, which ariſes from the mouth of the Euſtachian tube.

embrace

embrace it closely, and their contractions force down the food.

LIII. The STYLO-PHARYNGEUS, arises from the root of the styloid process. It is a long slender and beautiful muscle; it expands fleshy upon the side of the pharynx; extends so far as to take a hold upon the edge of the thyroid cartilage; it lifts the pharynx up to receive the morsel, and then straitens and compresses the bag, to push the morsel down, and by its hold upon the thyroid cartilage, it commands the larynx also, and the whole throat.

The pharynx being surrounded by many irregular points of bone, its circular fibres or constrictors have many irregular origins. The constrictor might fairly enough be explained as one muscle, but the irregular origins split the fibres of the muscle, and give occasion of dividing the constrictor into distinct parts; for one bundle arising from the occipital bone and os petrosum, from the tongue, the pteregoid process, and the two jaw-bones, is distinguished as one muscle, the constrictor superior *. Another bundle arising from the os hyoides, is named the constrictor medius †. A third bundle, the lowest of the three, arising from the thyroid and cricoid cartilages, is named the constrictor inferior ‡.

LIV. The CONSTRICTOR SUPERIOR arising from the basis of the skull, from the jaws, from the palate, and from the root of the tongue, surrounds the upper part of the pharynx; and it is not one circular muscle, but two muscles divided in the middle line behind, by a distinct raphaseam, or meeting of the opposite fibres.

LV. The CONSTRICTOR MEDIUS rises chiefly from the round point in which the os hyoides terminates; it

* These good opportunities of names have not been disregarded: this muscle has been named CEPHALO-PHARYNGEUS, PTEREGO-PHARYNGEUS, MYLO-PHARYNGEUS, GLOSSO-PHARYNGEUS.

† This one is named HYOPHARYNGEUS, or SYNDESMO PHARYNGEUS, from its origin in the cartilage also of the os hyoides.

‡ This, of course, is named THYRO-PHARYNGEUS, and CRICO-PHARYNGEUS.

also

alſo ariſes from the cartilage of the os hyoides (i. e.) where the horns are joined to the body. The tip of the horn being the moſt prominent point, and the centre of this muſcle, it goes upwards and downwards, ſo as to have ſomething of a lozenge-like ſhape; it lies over the upper conſtrictor like a ſecond layer, its uppermoſt peak, or pointed part touches the occipital bone, and its lower point is hidden by the next muſcle.

LVI. The CONSTRICTOR INFERIOR ariſes partly from the thyroid, and partly from the cricoid cartilage; and it again goes alſo obliquely, ſo as to overlap or cover the lower part of the conſtrictor medius. This, like the other two conſtrictors, meets its fellow in a tendinous middle line; and ſo the morſel admitted into the pharynx by the dilatation of its arches, is puſhed down into the œſophagus by the forces of theſe conſtrictores pharyngis, aſſiſted by its ſtyloid muſcles.

LVII. The ŒSOPHAGUS is merely the continuation of the ſame tube. It lies flat upon the back-bone, and it is covered in its whole length by a muſcular coat, which is formed, not like this of the pharynx, of circular fibres, but of fibres running according to its length chiefly. And this muſcle ſurrounding the membraneous tube of the œſophagus like a ſheath, is named (LVIII.) VAGINALIS GULÆ.

MUSCLES OF THE TONGUE.

THE muſcles of the tongue are large bundles of fleſh which come from the os hyoides, the chin, and the ſtyloid proceſs. Their thickneſs conſtitutes the chief bulk of the tongue. Their actions perform all its motions.

LIX. The HYOGLOSSUS is a comprehenſive name for all thoſe which ariſe from the os hyoides. The muſcles from the os hyoides go off in three faſciculi, and were once reckoned as diſtinct muſcles. That portion which ariſes from the baſis of the os hyoides, was called BASIOGLOSSUS; that which ariſes from the cartilaginous joining of the body and horn, was called CHON-

CHONDROGLOSSUS; and that which arifes from the horn itfelf, was named CERATOGLOSSUS; or the terms were all bundled together in the perplexed names of BASIO-CHONDRO-CERATO-GLOSSUS.

The hyogloffus, then, is all that mufcular flefh which arifes from the whole length of the os hyoides, and which, by the changing form of the bone in its bafis, cartilage and horn, has a flight mark of divifion, but which lie all in one plain, and need not have diftinct names.

LX. The GENIO GLOSSUS arifes from the rough tubercle behind the fymphifis of the chin. It has a very narrow or pointed origin; it fpreads out fan-like, as it goes towards the tongue; and it fpreads with radii, upwards and backwards, making the chief part of the fubftance of the tongue.

LXI. The LINGUALIS is an irregular bundle of fibres which runs according to the length of the tongue; it lies betwixt the ftylogloffus and the genio-gloffus, and as it is in the centre, and unconnected with any bone, it is named lingualis, as arifing in the tongue itfelf.

The geniogloffi mufcles form by far the larger part of the tongue, and lie in the very centre. They go through the whole length, (i. e.) from the root to the tip of the tongue, and from the radiated form of their fibres, they perform every poffible motion; whence this was named by Winflow, mufculus POLYCHRESTUS, for its rays proceed from one point or centre, and thofe which go to the point of the tongue, pull the tongue backwards into the mouth. Thofe which go backwards, thruft the tongue out of the mouth. The middle fibres acting, make the back of the tongue hollow, while the tip and the root of the tongue both rife.

The hyogloffi mufcles lie on either fide of the genio-hyoidæi, and make up the fides of the tongue, and their chief action would feem to be this, that the hyo-gloffus mufcle of either fide acting, the edges of the tongue would be pulled downwards, and the back rounded, the oppofite of which motion is the genio-hy-

oidæi

oidæi acting, by which the middle of the tongue is made into a groove, the edges rising, and the centre being depressed. Lastly, The styloglossus is plainly intended for drawing the tongue deep into the mouth, particularly affecting the point of the tongue.

CHAP. III.

OF THE MUSCLES OF THE ARM,

INCLUDING THE MUSCLES OF THE SCAPULA, ARM, FORE-ARM, AND HAND.

MUSCLES OF THE SCAPULA.

THE great peculiarity of the arm is, the manner of its connection with the breast, to which it is fixed by the slight ligaments of the clavicle only: but its union to the body is secured by its strong and numerous muscles, by which indeed it may be said both to be fixed and moved. Though it were perhaps more regular to describe first the muscles of the trunk, it will be more easy and natural to describe first the broad muscles belonging to the scapula, which cover almost the whole trunk, and hide its proper muscles, viz. those which move the ribs and spine. For the muscles which move the scapula lie upon the trunk; those which move the arm lie upon the scapula; those which move the fore-arm lie upon the arm; and those for moving the hand and fingers lie upon the fore-arm. The leg requires but one chief motion, viz. backwards and forwards, flexion and extension. It has no other motions than those of the thigh and of the knee; but the arm requires an easy and circular motion, and its joints are multiplied: for it has the wrist turning round; it has the elbow for hinge-like motions; it has the shoulder-joint upon which the arm rolls; and to assist all these, the scapula, which is the centre of all these motions, is itself moveable; after a certain point of elevation, all the motion

motion in raifing the arm is performed, not by the motions of the fhoulder-bone upon the fcapula, but by the fcapula upon the trunk. For whenever the fhoulder-bone rifes to the horizontal direction, it is checked by the acromion, which hangs over it; and if the arm is to be raifed higher ftill, the fcapula muft roll; it turns upon the point of the clavicle, and in turning, it glides upon thofe mufcles, which are like a cufhion betwixt it and the trunk.

The mufcles which move the fcapula, come from the breaft to move it forwards; from the neck, to move it upwards; from the fpines of the vertebræ, to move it backwards; and from the fide, that is, from the ribs, to move it downwards.

LXII. The TRAPEZIUS is named from its lozenge form; or is often named CUCULARIS, from its refembling the monk's cowl, hanging back upon the neck. It is one of the moft beautiful mufcles in the body; and the two mufcles together cover all the fhoulders and neck, with a lozenge-like form, with neat and fharp points, extending from the tip of one fhoulder to the tip of the other, and from the nape of the neck quite down to the loins. It arifes firft by a ftrong tendon from the moft pointed part of the occipital bone, and along the tranfverfe fpine quite to the maftoid procefs; from this point all down the neck, it has no hold of the vertebræ, but arifes from its fellow in a ftrong tendon, which, extending like a bow-ftring down the neck, over the arch of the neck, and not touching the vertebræ till it comes down to the top of the back, is named LIGAMENTUM NUCHÆ. The tendon begins again to take hold of the fpines of the two laft vertebræ of the neck, and arifes from all the fpinous proceffes of the back, downwards; from this long origin its fibres converge towards the tip of the fhoulder: it alfo comes a little forward over the fide of the neck.

It is implanted into one-third of the clavicle neareft the fhoulder; into the tip of the acromion; into the whole length of the fpine, from which the acromion rifes;

rifes; and its fibres arifing from along the neck and back, and converging almoft into a point, muft have various effects, according to the different fibres which act: for thofe which come downwards muft raife the fcapula; thofe which come from the middle of the back muft carry it directly backwards; thofe which come from the lower part of the back muft deprefs it; and thofe different fibres acting in fucceffion, muft make the fcapula roll. The trapezius is chiefly a mufcle of the fcapula, but it muft be alfo occafionally a mufcle of the head, pulling the head backwards, and bending the neck.

Three other mufcles which raife the fcapula, or carry it backwards, lie fo much in the fame plane, and are fo little divided from each other, that they might almoft be reckoned different portions of the fame.

LXIII. LEVATOR SCAPULÆ, named alfo LEVATOR PROPRIUS ANGULARIS, is a fmall thin flip of flefh, which arifes from the four or five uppermoft vertebræ of the neck, at their tranfverfe proceffes, by three or four and fometimes five diftinct heads. The heads join to form a thin and flat ftripe of mufcle, about three inches in breadth, which is fixed by a flat thin tendon to the upper corner of the fcapula, to pull it upwards, as in fhrugging the fhoulders; whence it is named MUSCULUS PATIENTIÆ.

LXIV. and LXV. The RHOMBOID MUSCLE ftretches flat, neat, and of a fquare form, betwixt the fpine and the whole line of the bafe of the fcapula. One part arifes from the three lower fpinous proceffes of the neck, and is implanted into the bafe of the fcapula higher than the rifing of the fpine of the fcapula; another portion arifes from the fpinous proceffes of the firft four vertebræ of the back, runs exactly in the fame plane with the other into the bafe of the fcapula below the fpine. The part arifing from the three vertebræ of the neck is flightly divided from that which arifes from the four vertebræ of the back, though not diftinctly, and often not at all. I would reckon this but one mufcle, but it

it has been commonly diſtinguiſhed into (LXIV.) the RHOMBOIDES MINOR, the uppermoſt portion, and (LXV.) the RHOMBOIDES MAJOR, the lower portion. Theſe are ſeen after raiſing the trapezius; and the uſes of the trapezius, levator ſcapulæ, and rhomboides, are to raiſe the ſcapula or to carry it backwards. The muſcles which move the ſcapula downwards and forwards, viz. the pectoralis minor and the ſerratus major anticus, lie upon the fore part of the breaſt.

LXVI. The SERRATUS MAJOR ANTICUS lies upon the ſide of the cheſt ariſing from the ribs; and as the ribs have interſtices betwixt them, every muſcle ariſing from the ribs ariſes by diſtinct portions from each rib: all ſuch diſtinct and pointed ſlips are named digitations, tongues, or ſerræ, from their reſembling the teeth of a ſaw; and every muſcle ariſing from the ribs muſt be a ſerrated muſcle. The ſerratus major anticus is that great and broad muſcle, the chief part of which lies under the ſcapula; and nothing of which is ſeen but the fleſhy tongues, by which it ariſes from the ſides of the ribs. It is all fleſhy, and is of a conſiderable breadth and ſtrength: it ariſes from all the true ribs, except the firſt, and from three of the falſe ribs: its indigitations, of courſe, ſpread all over the ſide of the thorax like a fan: its upper indigitations lie under the pectoralis major, and its lower indigitations are mixed with the beginning of the external oblique muſcle of the abdomen. Its middle indigitations are ſeen ſpreading upon the ſides of the thorax: it lies thick and fleſhy under the ſcapula, and is a part of that cuſhion on which the ſcapula glides: its fibres converge towards a narrower inſertion; and the muſcle ends thick and fleſhy in the whole length of that line which we call the baſis of the ſcapula, and is, as it were, folded round it; ſo that this muſcle, which comes from before, is implanted along with the rhomboides, which comes from behind.

Perhaps, in difficult breathing, the ſhoulder-blade being raiſed and fixed by its own muſcles, the ſerratus major may aſſiſt in heaving up the ribs; but its

chief

chief operation is upon the ſcapula; for when the whole acts, it pulls the ſcapula downwards and forwards. When only the lower portions act, it pulls the lower angle of the ſcapula forwards, by which the ſcapula rolls, and the tip of the ſhoulder is raiſed: when the upper part acts in conjunction with the little pectoral muſcle, the tip of the ſhoulder is fixed and pulled downwards towards the cheſt, and the lower corner of the ſcapula rolls backwards.

LXVII. The PECTORALIS MINOR lies under the pectoralis major, cloſe upon the ribs; and as it ariſes from the third, fourth, and fifth ribs, it alſo is a ſerrated muſcle, and was named ſerratus minor anticus: its three digitations are very thick and fleſhy; they ſoon converge ſo as to form a ſmall, but thick and fleſhy muſcle, which, terminating in a point, is inſerted into the very apex of the coracoid proceſs: by pulling the coracoid proceſs forewards and downwards, it will roll the ſhoulder.

LXVIII. The SUBCLAVIAN MUSCLE is another concealed muſcle of the ſcapula; for the clavicle is juſt the hinge upon which the ſcapula moves, and the ſubclavian muſcle ariſes by a flat tendon from the cartilage of the firſt rib; it becomes flat and fleſhy, and lies along betwixt the clavicle and the firſt rib; it ariſes at a ſingle point of the rib, flat and tendinous; but it is inſerted into a great length of the clavicle, beginning about two inches from the ſternum, and being inſerted all along the clavicle, quite out to where it is joined to the acromion proceſs: its chief uſe (ſince the rib is immoveable), muſt ſurely be to pull the clavicle, and conſequently the ſhoulder downwards, and ſo to fix them.

Many have affected to find other muſcles of reſpiration than thoſe which directly belong to the ribs. Among theſe are reckoned the ſerratus major, the pectoralis minor, &c.; but there is much reaſon to doubt whether any muſcles can have much effect which do not belong properly to the ribs: and it is manifeſt, that the ſubclavian can have none, ſince the firſt rib is quite rigid,

rigid, has so little length of cartilage, that it cannot bend nor move.

The scapula is thus moved in every possible direction upwards, by the levator and the trapezius; backwards, by the rhomboides, assisted by the middle portions of the trapezius; downwards and backwards by the lowest order of fibres in the trapezius; downwards and forwards by the serratus major anticus; directly downwards by the serratus, balanced by the trapezius, and assisted by the subclavius; and directly forewards by the pectoralis minor.

MUSCLES OF THE ARM;

VIZ. THOSE MOVING THE OS HUMERI, OR ARM-BONE.

LXIX. The PECTORALIS MAJOR is a large thick and fleshy muscle which covers all the breast. It arises from two-thirds of the clavicle next the sternum; from all the edge of the sternum, the cartilaginous endings of the three lower true ribs. Where it arises from the sternum, it is tendinous, and the fibres from the opposite muscles cross and mix, so as to make a sort of fascia covering the bone. It is fleshy where it arises from the ribs, and there it mixes with the external abdominal muscle. The fibres approach each other till they form a flat tendon about an inch in breadth; and as the fibres approach each other, they cross in such a way, that the lower edge of the muscle forms the upper edge of the tendon, which is still flat, but twisted: its implantation is into the edge, if I may call it so, of the groove or rut of the biceps tendon. That part which arises from the clavicle is a little separated from that which arises from the sternum; a fatty line makes the distinction; and they are sometimes described as two parts: it is those two bundles chiefly which cross each other to make the plaited appearance. The pectoralis, among others, has been made a muscle of respiration *.

LXX. The

* Haller tells us, that when, at any time, he had rheumatism in this muscle, his breathing was checked; and when he had difficult

LXX. The LATISSIMUS DORSI is the broadeſt, not only of the back, but perhaps of the whole body. It is a beautiful muſcle, covering all the lower part of the back and loins, and reaching to the arm, to be the antagoniſt to the pectoral muſcle. It ariſes by a broad, flat, and gliſtening tendon, which covers all the loins, and which is in ſome degree the root of other muſcles, eſpecially of the longiſſimus dorſi. This broad ſilvery tendon, begins exactly in the middle of the back; it ariſes from the lower vertebræ of the loins, from the ſpines and knobs of the back of the ſacrum, and from the back part of the circle of the os ilium; this laſt, is the only part that is fleſhy. The flat tendon gradually paſſes into a flat and regular muſcle, which wraps round the ſide of the body, and as it lies over the corner of the ſcapula, it receives a ſmall fleſhy bundle from it; and as it paſſes over the lower ribs, it has ſome tendinous ſlips ſent into it, by which it is attached to the ribs. Its fibres converge: for the lower ones aſcend; the upper ones go directly acroſs. And theſe different orders, not only meet to form its flat tendon, but they croſs each other, like thoſe of the pectoral muſcle: Here alſo the tendon is twiſted, and the upper edge of the muſcle forms the lower edge of the flat tendon; which, paſſing into the axilla, turns under the arm-bone, and is implanted into it, on the inner edge of the bicipital groove; ſo the tendons of the pectoralis and latiſſimus meet each other; they in fact, join face to face, as if the one tendon ended directly in the other; and both united, make a ſort of lining for the groove, or a tendinous ſheath, for the long tendon of the biceps to run on.

Theſe two muſcles form the axilla or arm-pit; and although each has its peculiar offices, their chief opera-

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ficult breathing, he found great relief by fixing the hands, raiſing the ſhoulders, and acting with the pectoral muſcles. It ſeems confirmed by theſe facts, that aſthmatics take this poſture; women in labour fix their arms, by reſting upon the arms of their chair; thoſe who play on wind inſtruments raiſe the ſhoulders in ſtraining.

tion is when they coincide in one action; and that action is exceedingly powerful, both by the great ſtrength of either muſcle, and by their being implanted into the arm-bone, four inches below its head. The pectoralis major, is for pulling the arm forwards, as in laying the arms acroſs the breaſt, or in carrying loads in the arms; and it forms the border of the axilla before. The latiſſimus dorſi has a wider range; when the arm is raiſed, it brings it downwards as in ſtriking with a hammer, or downwards and backwards, as in ſtriking with the elbow or in rolling the arm inwards and backwards, as in turning the palm of the hand behind the back, whence it has the obſcene name of MUSCULUS SCALPTOR ANI, or TERSOR ANI; and it forms the back edge of the axilla. The edges of theſe two muſcles receive the preſſure of crutches, and defend the veſſels and nerves; when both muſcles act, the arm is preſſed directly downwards, as in riſing from our ſeat, or in holding a bundle under the arm; or when the arm is fixed, theſe muſcles raiſe the body as in the example juſt mentioned, of riſing from our ſeat, or in walking with a ſhort ſtick, or in raiſing ourſelves by our hands over a high beam.

LXXI. The DELTOIDES is the firſt of thoſe muſcles which ariſe from the ſcapula, to be inſerted into the ſhoulder bone. It is named deltoid muſcle, from its reſembling the letter Δ of the Greeks; it is thick and fleſhy, and covers the top of the ſhoulder, filling up the ſpace betwixt the acromion proceſs and the ſhoulder-bone; it ariſes from all that part of the clavicle, which is not occupied by the pectoralis muſcle, and is ſeparated from it only by a fatty line; it ariſes again in another bundle, from the point of the acromion proceſs, and this middle bundle is alſo inſulated by a fatty line on either ſide of it. The third bundle ariſes from the ſpine of the ſcapula, behind the acromion proceſs: And thus the muſcle has three converging heads, viz. a head from the outer end of the calvicle, a head from the acromion, or tip of the ſhoulder, a head from the ridge of the ſpine, each divided from the other by a

fatty line *. Thefe heads or bundles of fibres, meeting about one-third down the humerus, form a fhort, flat, and ftrong tendon, which grafps, or almoft furrounds the fhoulder-bone.

Thefe three diftinct heads muft be obferved in fpeaking of the ufe of the mufcle; for though the chief ufe of the mufcle be to raife the arm, this is not the ufe of it in all circumftances; for the outer and inner heads, lying by the fide of the fhoulder-bone, and below the joint, do, when the arm is lying flat by th fide, affift the pectoral and latiffimus dorfi mufcles in drawing it clofe to the fide. But when the middle bundle raifes the arm, in proportion as the middle bundle raifes the arm, it lofes of its power; and in proportion as it lofes of its power, the fide portions, having come into a new direction, begin to help: nay, when the arm is raifed to a certain point, more power ftill is required, and the clavicular part of the pectoral mufcle alfo comes to affift. It is in this fucceffion, that the feveral bundles of fibres act; for if they began all at once to act, the arm fhould rather be bound down by the lateral portions, than raifed by the middle one.

LXXII. Coraco brachialis. — The coraco brachialis, fo named from its origin and infertion, is a long and rather flender mufcle.

It arifes from the coracoid procefs of the fcapula, along with the fhort head of the biceps mufcle, and it is clofely connected with this head, almoft its whole length: it is fmall at its beginning; it grows gradually thicker, as it defcends; it is all flefhy, and is inferted by a very fhort tendon into the os humeri, nearly about its middle, betwixt the brachialis, and the third head of the triceps. It is perforated by the external cutaneous nerve. This was obferved by Cafferius, an Italian anatomift; and the mufcle is often named, musculus perforatus casserii.

Its action is very fimple, to raife the arm obliquely forwards and upwards, and confequently to give a

* Albinus has diftinguifhed it into feven fafciculi or bundles; a very fuperfluous accuracy.

 degree

degree of rotation. It will alſo have a chief effect in pulling the arm towards the ſide of the body.

LXXIII. The SUPRA SPINATUS is ſo named from its occupying the hollow of the ſcapula above the ſpine.

It ariſes from the back of the ſcapula, from the ſpine, and from the edge or coſta; it is exceedingly thick and fleſhy, filling up all the hollow; and it is firmly encloſed in this triangular hollow, by a ſtrong tendinous expanſion, which paſſes from the edge of the ſcapula, to the ridge of the ſpine: it is conſequently a muſcle of a triangular figure, thick and ſtrong; it paſſes under the acromion, and degenerates into a tendon there, and going under the acromion, as under an arch, and over the ball of the humerus, it adheres to the capſule of the ſhoulder-joint, and is at laſt implanted by a broad ſtrong tendon into the great tuberoſity on the head of the bone.

It is evidently deſigned for raiſing the humerus directly upwards, and by its attachment to the capſule, the capſule is drawn up when the arm is raiſed, ſo that though lax, it cannot be catched in the joint. It exactly performs the ſame motion with the middle part of the DELTOIDES, lies in the ſame direction with it, and aſſiſts it.

LXXIV. INFRA SPINATUS, is like the former in all reſpects, of the ſame uſe, and aſſiſting it.

This alſo is of a triangular ſhape, and is fully one half larger than the ſupra ſpinatus; and the ſupra ſpinatus ariſes from all the triangular cavity above the ſpine, this ariſes from all the triangular cavity below it.

It ariſes fleſhy, from all the back of the ſcapula below the ſpine itſelf, and from all the baſe of the ſcapula, below the beginning of the ſpine, and alſo from the lower margin of the ſcapula. It is very thick and ſtrong, filling up the triangular cavity entirely; and it is cloſed in like the former, by a ſtrong tendinous expanſion; it begins to grow tendinous about its middle, but it continues alſo fleſhy till it paſſes over the ſocket of the ſhoulder joint: It alſo is connected with the capſular

ſular ligament, is inſerted into the ſame tuberoſity with the former, and has exactly the ſame uſes, viz. preventing the capſule from being catched in the joint, and raiſing the arm upwards, and inclining it a little outwards, by a ſlight degree of rotation. And I do believe, that one great uſe of theſe two muſcles is, when the arm is much extended backwards, to prevent the head of the humerus from ſtarting out of its ſuperficial ſocket.

LXXV. The TERES MINOR is a third muſcle which co-operates with theſe. This, and another, are ſo named from their appearance, not from their ſhape, for they ſeem round when ſuperficially diſſected, becauſe then their edges only are ſeen; but when fully diſſected from the other muſcles, they are rather flat. The teres minor is a long, ſmall, fleſhy muſcle; it ariſes from the angle, and all the lower edge of the ſcapula: it is like the infra ſpinatus; it becomes early tendinous; but the tendon is accompanied with fleſhy fibres from below; its flat tendon, in paſſing over the joint is attached to the capſule, and is finally inſerted into the great tuberoſity of the ſhoulder-bone, ſo that it muſt have exactly the ſame uſes, as the two former muſcles. It is ſeparated from the infra ſpinatus, by that tendinous expanſion with which the latter is covered; it looks like a part of the ſame muſcle in its origin, where it lies upon the ſcapula; but is very diſtinct in its tendon. The ſupra ſpinatus, infra ſpinatus, and teres minor, raiſe the arm.

LXXVI. The TERES MAJOR, is in ſhape like the former, lies lower upon the edge of the ſcapula, than the teres minor, and is thicker and longer than it.

It ariſes chiefly from the angle of the ſcapula; partly from the lower edge of the ſcapula, at its back part; it is connected with the TERES MINOR, and INFRA SPINATUS. It is a large, thick, and flat muſcle, and forms a flat ſtrong tendon, which paſſes under the long head of the triceps; it paſſes under the os humeri; turns round it, and is inſerted into the ridge, on the inner ſide of the groove, and gives ſome tendinous

fibres

fibres to line the groove. In ſhort, it accompanies the tendon of the latiſſimus dorſi, is inſerted along with it, and may be conſidered as the congenor of the latiſſimus dorſi; and the two tendons are incloſed in one common capſule, or ſheath of cellular ſubſtance.

Its uſe, then, is evidently to draw the humerus downwards and backwards, and to perform the ſame rotation of the arms, which the latiſſimus dorſi does.

LXXVII. The SUBSCAPULARIS lines all the concavity of the ſcapula like a cuſhion. It is like the ſurface of the ſcapula on which it lies, of a triangular ſhape; and from the convergence of all the fibres it is completely radiated or fan-like; it is very fleſhy, thick, and ſtrong; the radii are each minutely deſcribed by Albinus; but Sabbattier ſays, with good ſenſe, that he cannot diſtinguiſh them, ſo as to deſcribe them accurately; and he might have added, that there was not the ſhadow of a motive for waſting time in ſo trivial an employment as counting the bundles.

It ariſes from the two coſtæ, the baſe, and all the internal ſurface of the ſcapula. And indeed it is to favour this origin that the inner ſurface of the ſcapula is full of little riſings and hollows, to every one of which the muſcle adheres cloſely. Juſt under the coracoid proceſs, is the only part from whence it does not ariſe. That little ſpace is filled up with cellular ſubſtance.

Its alternately tendinous and fleſhy fibres are ſo rooted in the ſcapula, and ſo attached to its riſings and depreſſions, that it is difficultly cleaned away from the bone.

The tendon and upper edge of the muſcle is almoſt continuous with the ſupra ſpinatus; but from the manner of its inſertion, its effect is very oppoſite from that of the ſupra ſpinatus, for it goes round the os humeri to its inſertion, and it is fixed to the leſſer tuberoſity, therefore it both pulls the arm backwards and downwards, and performs the rotation like the teres major, and latiſſimus dorſi. It is alſo like all the other tendons, attached to the capſule, ſo as to prevent its being catched; and it is particularly uſeful by ſtrengthening the ſhoulder-joint.

OF THE MOTIONS OF THE HUMERUS.

Having thus defcribed all the mufcles which move this bone, I fhall review the order in which they are arranged, and mark their place and effects.

To diftinguifh clearly the function of each mufcle, we have but to mark the point to which it is attached.

1. Thofe implanted above the head of the bone muft raife the arm. Now the fupra fpinatus, infra fpinatus, and teres minor, are implanted into the great tubercle, and raife the arm; and the deltoides is implanted in the fame direction, and ftill lower, fo that it performs the fame action with a ftill greater degree of power.

2. There is implanted into the oppofite, or lower part of the head, the fubfcapularis, which, of courfe, draws the arm directly downwards and backwards.

3. There is implanted into the outer edge of the bicipital groove, the pectoralis major, and alfo the coraco-brachialis, which comes in the fame direction; and thefe two pull the arm inwards, towards the fide and forwards.

4. There are inferted into the infide, or lower fide of the groove, the latiffimus dorfi, and teres major, both of which pull the arm directly backwards, as they bend under the arm, to reach their infertion. They alfo roll the palm inwards and backwards. And it is eafy to obferve in what fucceffion thofe mufcles muft act, to defcribe the circular and rotatory motions of the arm.

Joints are more ftrengthened by the origin and infertion of mufcles around them, than by elaftic ligaments, which yield or tear; whereas the mufcles having a living power, re-act againft any feparating force. They contract, or, in other words, they are ftrong in proportion to the violence that the joint fuffers. Thus, in the fhoulder the capfule is fo lax, that there is a mechanical contrivance to prevent its being checked in the joint, and it is moreover fo weak, that, independent of its yielding eafily, it is alfo very eafily torn; but thefe mufcles furround the joint fo fairly, that their ftrength and their tendinous connexions with the head of the bone are

more

more than a compenſation for the looſeneſs of its capſular ligament. Were not the muſcles thus cloſely attached, the ſhoulders would be very often diſplaced, the glenoid cavity is ſo ſuperficial, and the burſa ſo lax; and ſurely it is for ſome ſuch purpoſe that the muſcles are planted ſo cloſely round the head; for when they are implanted at a diſtance from the centre, as one muſcle, the deltoid is, or as the biceps and triceps of the arm, or the hamſtrings, or tendo Achillis, the power is much increaſed. Here, in the muſcles ariſing from the ſcapula, power is ſacrificed to the firmneſs of the joint, and they are all implanted cloſely round the head of the bone.

The connection of the bones in this joint is in a manner formed by theſe muſcles, for the ſupra ſpinatus, infra ſpinatus, teres major and minor, and the ſubſcapularis, ſurround the joint very cloſely, cover the joint with their flat tendons, and ſo thicken the capſule, and increaſe its ſtrength.

The muſcles of the fore-arm are only four, the BICEPS and BRACHIALIS for bending, and the TRICEPS and ANCONÆUS for extending.

LXXVIII. BICEPS BRACHII FLEXOR is univerſally named BICEPS, from its having two very diſtinct heads. It is an exceedingly thick and ſtrong muſcle, for when it contracts, we feel it almoſt like a hard firm ball upon the fore part of the arm, and at the upper and moſt conſpicuous part of this ball is the union of the two heads.

The larger and thicker head ariſes from the coracoid proceſs, by a tendon which extends three inches along the forepart of the muſcle, in the form of an aponeuroſis, but at the back part the tendon is ſhort, and the muſcle is attached there to the fleſhy belly of the coraco-brachialis.

The ſecond, or long head, ariſes from the edge of the glenoid cavity, at its upper part; it is exceedingly ſmall and tendinous, and this long tendon runs down in its proper groove, till about the third part down the humerus the two heads meet. And though below this it is

but one fleſhy belly, yet here, as in other muſcles, the common diviſion betwixt its two origins may be ſtill obſerved.

It is earlier tendinous at the fore part and outer ſide; the tendon here ſends off that aponeurotic expanſion which covers all the arm below, and encloſes the muſcles as in a ſheath. The tendon, at firſt flat and large, becomes gradually ſmaller and rounder; it turns a little in its deſcent, ſo as to lay one flat edge to the radius, and another to the ulna; and it is at laſt implanted into that round tubercle, which is on the fore-part of the radius a little below its neck.

The great uſe of the biceps is to bend the fore arm with great ſtrength. But as it is inſerted into the tubercle of the radius, when the arm and hand are turned downwards, it, by acting, will pull them upwards, i. e. it will aſſiſt the ſupinators. Since both its heads are from the ſcapula, it will occaſionally move the humerus, as well as the fore-arm.

LXXIX. The BRACHIALIS INTERNUS lies immediately under the biceps, and is a very ſtrong fleſhy muſcle for aſſiſting the biceps in bending the arm. It is called BRACHIALIS, from its origin in the fore-arm, and INTERNUS, from its being within the biceps.

It ariſes from two-thirds of the os humeri at its fore part, by a ſort of forked head; for it comes down from each ſide of the deltoid. It continues its attachment all the way down the fore part of the humerus, to within an inch of the joint. It is very thick, fleſhy, and ſtrong; it is tendinous for about two inches in its fore part; and is inſerted by a flat ſtrong tendon into the coronoid proceſs of the ulna.

Other uſes are aſcribed to it, as the lifting up the capſule to prevent its being pinched. But the chief uſe of it is to bend the fore-arm. In a ſtrong man, it is exceedingly thick, and its edge projects from under the edge of the biceps, and is ſeen in the lateral view.

LXXX. TRICEPS EXTENSOR. — Upon the back part of the arm three muſcles have been deſcribed: the extenſor

tenſor longus, the extenſor brevis, and the brachialis externus; but there is, in fact, only one three-headed muſcle.

The longeſt head of this muſcle is in the middle. It ariſes by a flat tendon; from an inch of the edge of the ſcapula under the neck, and a little way from the origin of the long head of the biceps; and it is under this head that the tendon of the teres major paſſes to its inſertion.

The ſecond head is on the outſide of the arm, next in length to this. It ariſes from the arm-bone under the great tuber, and juſt below the inſertion of the teres minor. The long and ſecond heads meet about the middle of the humerus.

The third, or internal head, is the ſhorteſt of all. It begins at the inner ſide of the humerus, juſt under the inſertion of the teres major; and it ariſes from the inner part of the humerus, all the way down, and joins juſt where the ſecond head joins (i. e. about the middle). All theſe heads ſtill continue adhering to the humerus (as the brachialis does on the fore ſide), quite down to within an inch of the joint, and then a ſtrong thick tendon is formed, by which it is implanted ſtrongly in the projecting heel of the ulna, named olecranon, by which projection of the bone the muſcle has great power, and the power is increaſed by an increaſed length of the proceſs in dogs, and other animals which run or bound.

The whole forms a very thick and powerful muſcle, which covers and embraces all the back part of the arm; and its uſe is too ſimple to admit of any farther explanation, than juſt to ſay that it extends the hinge-joint of the elbow with great power; and that by its long head it may aſſiſt alſo to bend the arm-bone outwards and backwards.

Beſides bones, there is alſo another ſource of attachment for muſcles, that is, the tendinous expanſions: for the expanſions, which go on the ſurface like ſheaths, alſo dive betwixt the muſcles, and form ſepta, or partitions, from which their fibres ariſe.

One

One tendinous expanſion begins from the clavicle and acromion proceſs, or rather comes down from the neck: it is then ſtrengthened by the tendon of the deltoid muſcle; it deſcends, covering all the arm; and before it goes down over the fore-arm, it is again reinforced chiefly by the biceps, but alſo by the tendon of the triceps extenſor. One remarkable proceſs, or partition of this general faſcia, is ſent in from the ſheath to be fixed to the outſide of the humerus, all the way down to the ridge of the outer condyle. Another partition goes down, in like manner, to the inner condyle, along the ridge which leads to it; then the faſcia, taking a firm hold on the condyles, is greatly ſtrengthened about the elbow, and goes over the fore-arm, encloſing its muſcles in a very firm and cloſe ſheath; and it ſends partitions down among the ſeveral layers of muſcles in the fore-arm, which gives each of them a firm hold.

LXXXI. The ANCONÆUS is a ſmall triangular muſcle, placed on the back part of the elbow. It ariſes from the ridge and from the external condyle of the humerus, by a thick, ſtrong, and ſhort tendon. From this it becomes fleſhy, and after running about three inches obliquely backwards, it is inſerted by its oblique fleſhy fibres into the back part or the ridge of the ulna.

It is manifeſtly deſigned for the extenſion of the fore-arm, and has only that one ſimple action.

MUSCLES OF THE RADIUS, CARPUS, AND FINGERS.

The whole fore-arm is covered with a maſs of muſcles of great ſtrength, and ſo numerous and intricate, with a catalogue of names ſo difficult, and ſo diſtracting, that they ſhould be arranged and claſſed with much care, explaining to the ſtudent the reaſon and value of their names, and the place and effect of each claſs.

The fore-arm is covered with a faſcia, or ſtrong tendinous web, which, like that which covers the temporal muſcle, gives both origin and ſtrength to the muſcles which

which lie under it, which divides the ſeveral layers one from another, and helps them in their ſtrong actions, with that kind of ſupport which workmen feel in binding their arms with thongs. This faſcia is ſaid to proceed from the ſmall tendon of the biceps muſcle, though that were but a ſlender origin for ſo great a web of tendon, which not only covers the ſurface of the muſcles, but enters among their layers. This faſcia really begins in the ſhoulder, and has an addition and an increaſe of ſtrength from every point of bone; it is aſſiſted by each tendon, becauſe the tendons and faſcia are of one nature over all the body, and its connection with the tendon of the biceps is quite of another kind from that which has been ſuppoſed. I would not allow that the biceps tendon expands into the faſcia, but rather that the web receives the biceps tendon, which is implanted into it, and for this wiſe purpoſe, that when the fore-arm is to ſtrike, or the hand to graſp, the biceps firſt moves, and by making the faſcia tenſe, prepares the fore-arm for thoſe violent actions which are to enſue. Thus, it may be defined, a web of thin but ſtrong tendon, which covers all the muſcles of the fore-arm, makes the ſurface before diſſection firm and ſmooth, ſends down partitions, which are fixed into the ridges of the radius and ulna, enabling thoſe bones to give a broader origin to the muſcles, eſtabliſhing a ſtrong connection among the ſeveral layers, and making the diſſection more difficult.

The motions to be performed by the muſcles which lie upon the fore-arm are theſe three; to roll the hand, to bend the wriſt, to bend the fingers.

1. The turning of the hand, which is performed by rolling the radius on the ulna, is named pronation and ſupination. When we turn the palm down, it is ſaid to be prone; when we turn the palm upwards, it is ſupine. This is pronation and ſupination. The muſcles which perform theſe motions are the PRONATORS and the SUPINATORS, and the motion itſelf is beſt exemplified in the turning a key in a lock, or in the guards of fencing, which are formed by a continual play of the radius

upon

upon the ulna, carrying the wriſt round in the half circle.

2. The wriſt is called the CARPUS, and therefore thoſe muſcles which ſerve for bending or extending the wriſt, are the FLEXORS and EXTENSORS of the carpus.

3. The bending and extending of the fingers cannot be miſtaken, and therefore the flexors and extenſors of the fingers need not be explained.

Theſe muſcles are denominated from their uſes chiefly; but if two muſcles perform one motion, they may be diſtinguiſhed by ſome accident of their ſituation or form. And thus, if there be two benders of the fingers, one above the other, they are named FLEXOR SUBLIMIS, and FLEXOR PROFUNDUS, i. e. the ſuperficial and deep flexors. If there be two flexors of the carpus, one is named FLEXOR RADIALIS CARPI, by its running along the radius, the other flexor ulnaris carpi, from paſſing in the courſe of the ulna. And if there be two pronators, one may be diſtinguiſhed pronator teres, from its round ſhape, the other pronator quadratus, from its ſquare form. And this, I truſt, will ſerve as a key to what is found to be a ſource of inextricable confuſion.

It will be eaſy to make the origins and inſertions ſtill more ſimple than the names; for all the muſcles ariſe from two points and have but two uſes.

This aſſertion ſhall be afterwards qualified, with a few exceptions; but at preſent it ſhall ſtand for the rule of our demonſtration; for all the muſcles ariſe from two points, the external and internal condyle. The internal condyle is the longer one, and gives moſt power: more power is required for bending, graſping, and turning the hand inwards; therefore all the muſcles which bend the hand, all the muſcles which bend the fingers, and the principal pronator, or that muſcle which turns the palm downwards, ariſe from the internal condyle.

The external condyle is ſhorter; it gives leſs power; there is little reſiſtance to opening the hand, and little power

power is required in extending the fingers; and ſo all the muſcles which extend the wriſt or the fingers, or roll the hand outwards to turn it ſupine, ariſe from the external condyle. So that when we hear a pronator or a flexor named, we know that the origin muſt be the internal condyle, and the inſertion is expreſſed by the name. Thus a pronator radii goes to the radius; a flexor carpi goes to the wriſt; a flexor digitorum goes to the fingers; and a flexor pollicis goes to the thumb: and they all iſſue from the inner condyle as from a centre.

And, again, when a ſupinator or extenſor is named, we know where to look for it; for they alſo go out from one common point, the external condyle; and the ſupinator radii goes to the radius; the extenſor carpi goes to the wriſt; the extenſor pollicis goes to the thumb; and the extenſor indicis to the fore finger.

FLEXORS.

The MUSCLES cloſing and bending the hand, ariſe from the internal condyle. They are,

The PRONATOR TERES, rolling the radius inward.

PALMARIS LONGUS, FLEXOR CARPI RADIALIS, ——— ——— ULNARIS,	bending the wriſt.
——— DIGITORUM SUBLIMIS, ——— ——— PROFUNDUS, ——— LONGUS POLLICIS,	bending the fingers and thumb.

And, laſtly, the PRONATOR QUADRATUS, which is the ſingle muſcle out of that ſcheme which I have propoſed.

LXXXII. The PRONATOR TERES RADII is of the outermoſt layer of muſcles, is ſmall and round; named pronator from its office of turning the radius, and teres from its ſhape, or rather to diſtinguiſh it from the pronator quadratus, which is a ſhort ſquare muſcle and which lies deep, being laid flat upon the naked bones.

The pronator teres ariſes chiefly from the internal

tubercle

tubercle of the humerus, at its lower and fore part. It has a second origin from the coronoid process of the ulna; these form two portions, betwixt which passes the radial nerve. The muscle thus formed is conical, is gradually smaller from above downwards, is chiefly fleshy, but is also a little tendinous, both at its origin and at its insertion; and stretches obliquely across the fore-arm, passing over the other muscles to be inserted in the outer ridge of the radius, about the middle of its length.

Its use is to turn the hand downwards, by turning the radius; and it will also, in strong actions, be brought to bend the fore-arm on the arm, or the reverse, when the fore-arm is fixed, and we are to raise the trunk by holding with the hands.

LXXXIII. The PALMARIS LONGUS is a long thin muscle, which, although it seems to have another use in its expansion into the aponeurosis, yet is truly, by insertion into the annular ligament of the wrist, a flexor of the wrist, and, in some degree, a pronator of the radius.

It arises from the internal condyle of the os humeri, and is the first of five muscles which have one common tendon going out, like radii, from one common centre, viz. the palmaris; the flexor radialis; the flexor ulnaris; the flexor digitorum sublimis; the flexor digitorum profundus.

The palmaris longus arises from the inner condyle of the os humeri, and also from the intermuscular tendon, which joins it with the flexor radialis and flexor digitorum sublimis, and from the internal surface of the common sheath. Its fleshy belly is but two inches and a half or three inches in length; and its long slender tendon descends along the middle of the fore-arm to be inserted into the fore part of the annular ligament of the wrist, just under the root of the thumb. This tendon seems to give rise to the very strong thick aponeurosis of the palm of the hand, (under which all the muscles of the hand run, and which conceals the arch of blood vessels, and protects them), thence the muscle has its name.

name. But it is a very common miſtake to think, that becauſe tendons are fixed to the ſheaths, the ſheaths are only productions of the tendons; whereas the ſheaths do truly ariſe from bones. The faſcia, which the deltoides is thought to form, ariſes from the acromion and clavicle; and the faſcia, which the biceps is thought to produce, ariſes from the condyles of the humerus; and that great ſheath of tendon which is made tenſe by the muſculus faſcialis of the thigh, does not ariſe from that muſcle, but comes down from the ſpine of the ilium, ſtrengthened by expanſions from the oblique muſcles of the abdomen; in the preſent inſtance, we have the cleareſt proof of faſcia being derived from ſome other ſource than the tendons, for ſometimes the palmaris muſcle is wanting, when ſtill the tendinous expanſion is found, and ſome pretend to ſay, that the expanſion is wanting when the muſcle is found. The aponeuroſis, which covers the palm, is like the palm itſelf, of a triangular figure; it begins from the ſmall tendon of the palmaris longus, and gradually expands, covering the palm down to the ſmall ends of the metacarpal bones. Its fibres expand in form of rays; and towards the end, there are croſs bands which hold them together, and make them ſtronger; but it does not cover the two outer metacarpal bones (the metacarpal of the fore finger, or of the little finger), or it only covers them with a very thin expanſion.

Now this palmar expanſion alſo ſends down perpendicular diviſions, which take hold on the edges of the metacarpal bones: and thus there being a perpendicular diviſion to each edge of each metacarpal bone, there are eight in all, which form canals for the tendons of the fingers, and for the lumbricales muſcles.

LXXXIV. The PALMARIS BREVIS is a thin flat cutaneous muſcle, which ariſes properly from the edge of the palmar aponeuroſis, near to the ligament of the wriſt; whence it ſtretches acroſs the hand in thin faſciculi of fibres, which are at laſt inſerted into the os piſiforme, and into the ſkin and fat on the edge of the palm. This

is

is the PALMARIS CUTANEUS of ſome authors, for which we can find no uſe, except of drawing in the ſkin of the hand, and perhaps making the palmar expanſion tenſe.

LXXXV. The FLEXOR CARPI RADIALIS is a long thin muſcle ariſing from the inner condyle, ſtretching along the middle of the fore-arm ſomewhat in the courſe of the radius, and is one of the five muſcles which riſe by one common tendon, and which are, for ſome way, tied together.

It ariſes tendinous from the inner condyle; the tendon very ſhort and thick. This tendon at its origin, is ſplit into many (ſeven) heads, which are interlaced with the heads of the ſublimis, profundus palmaris, &c.; conſequently this muſcle not only ariſes from the internal condyle, but alſo from the intermuſcular partitions (as from that betwixt it and the ſublimis): it forms a long tendon, which becoming at laſt very ſmall and round, runs under the annular ligament: it runs in a gutter peculiar to itſelf; but in this canal it is moveable, not fixed: it then expands a very little, and is inſerted into the metacarpal bone of the fore-finger, alſo touching that which ſupports the thumb.

Its uſe is chiefly to bend the wriſt upon the radius. But when we conſider its oblique direction, it will alſo be very evident, that it muſt have ſome effect in pronation; and this, like many of the muſcles of the fore-arm, although deſigned for a different purpoſe, will alſo have ſome effect in bending the fore-arm at the elbow joint.

LXXXVI. The FLEXOR CARPI ULNARIS is a long muſcle, much like the former; but as its courſe is along the radius, or upper edge of the fore-arm, this runs along the ulna or lower edge.

It comes off tendinous from the inner condyle of the os humeri, by the common tendon of all the muſcles: it has alſo, like the pronator teres, a ſecond head, viz. from the olecranon proceſs of the ulna, which ariſes fleſhy, and the ulnar nerve perforates betwixt theſe heads. The flexor ulnaris paſſes all along the flat ſide of the ulna, betwixt

betwixt the edge of the ſublimis and the ridge of the bone: and here it has a third origin of oblique fibres, which come from the edge of the ulna, two-thirds of its length. Its tendon begins early on its upper part, by which it has ſomewhat the form of a penniform muſcle. It has ſtill a fourth origin from the inter-muſcular partition, which ſtands betwixt it and the ſublimis flexor; and is alſo attached to the internal ſurface of the common faſcia of the arm. Its long tendon is at laſt inſerted into the os piſiforme at its fore part, where it ſends off a thin tendinous expanſion to cover and ſtrengthen the annular ligament; and alſo a thin expanſion towards the ſide of the little finger to cover its muſcles.

This is to balance the flexor radialis: acting together, they bend the wriſt with great ſtrength; and when this muſcle combines in action with the extenſor carpi ulnaris, they pull the edge of the hand ſideways.

LXXXVII. The FLEXOR DIGITORUM SUBLIMIS, is named SUBLIMIS from being the more ſuperficial of the two muſcles; PERFORATUS, from its tendon being perforated by the tendon of that which lies immediately below. It lies betwixt the palmaris longus and flexor ulnaris: it is a large fleſhy muſcle; and not only its tendons, but its belly alſo, is divided into four faſciculi, correſponding with the fingers which it is to ſerve.

It ariſes from the internal condyle, along with the other four muſcles; from the ligament of the elbow joint; from the coronoid proceſs of the ulna; and from the upper part of the radius, at the ſharp ridge. By theſe origins, it becomes very fleſhy and thick; and, a little above the middle of the fore-arm, divides into four fleſhy portions, each of which ends in a ſlender tendon. The tendons begin at the middle of the fore-arm, or near the diviſion; but they continue to be joined to each other by fleſhy fibres ſome way down: and indeed the fleſhy fibres ceaſe only, when it is about to paſs under the annular ligament of the wriſt. At this place, a cellular ſtringy tiſſue connects the tendons with

with each other, and with the tendons of the profundus ; but after they have paſſed under the ligament, they expand towards the fingers which they are to ſerve. They each begin to be extended and flattened, and to appear cleft ; they paſs by the edge of the metacarpal bones, and eſcape from under the palmar aponeuroſis : and where it ends, viz. at the root of the fingers, a tendinous ſheath begins, in which theſe tendons continue to be encloſed.

The tendons are fairly ſplit juſt oppoſite to the top of the firſt phalanx : and it is at this point that the tendons of the deeper muſcle paſs through this ſplitting. The flattened tendon parts into two, and its oppoſite edges diverge ; the back edges meet behind the tendons of the profundus, and form a kind of ſheath for them to paſs in ; and then they proceed forward along the ſecond phalanx, into the fore part of which they are implanted.

This muſcle is exceedingly ſtrong : its chief office is to bend the ſecond joint of the fingers upon the firſt, and the firſt upon the metacarpal bone. And in proportion to the number of joints that a muſcle paſſes over, its offices muſt be more numerous ; for this one not only moves the fingers on the metacarpus, but the hand upon the wriſt, and even the fore-arm upon the arm.

LXXXVIII. The FLEXOR DIGITORUM PROFUNDUS vel PERFORANS, has the ſame origin, inſertion, and uſe, inſomuch that the deſcription of the laſt is applicable to this muſcle in almoſt every point. This is of a lower ſtratum of muſcles ; it lies deeper, and under the former, whence its name : and by this deeper ſituation it is excluded from any hold upon the tubercle of the humerus.

It ariſes from the ulna, along its internal ſurface, from the whole ſurface of the interoſſeous ligament, and alſo in ſome degree, from the intermuſcular membrane, which ſeparates this from the ſublimis.

This muſcle is ſmall, we may ſay compreſſed above ; but it grows pretty ſtrong and fleſhy, near the middle of

of the arm; it divides above the middle of the arm into four portions, correſponding with the four fingers; and it is about the middle of the arm, that the tendons begin, and continue to receive muſcular fibres from behind, all down to the ligament of the wriſt: at the wriſt theſe tendons are tied to each other, and to the tendons of the ſublimis, by looſe tendinous and cellular fibres. They diverge from each other, after paſſing under the annular ligament; and going along in the hollow of the bones, under the tendons of the ſublimis, they firſt paſs through the bridges formed by the palmar aponeuroſis, then enter the ſheaths of the fingers, and finally paſs through the perforations of the ſublimis, a little below the ſecond joint of the fingers: at this place the perforating tendons are ſmaller and rounder for their eaſy paſſage, and after paſſing, they again expand and become flat. They alſo above this, appear themſelves ſplit in the middle, without any evident purpoſe; they paſs the ſecond phalanx, and are fixed into the root of the third. And every thing that is ſaid of the uſe of the ſublimis, may be applied to this, only that its tendons go to the furtheſt joint.

LXXXIX. Lumbricales. — I ſhall here deſcribe, as a natural appendage of the profundus, the LUMBRICALES muſcles, which are four ſmall and round muſcles, reſembling the earth-worm, in form and ſize; whence they have their name. They ariſe in the palm of the hand, from the tendons of the profundus, and are therefore under the ſublimis, and under the palmar aponeuroſis. They are ſmall muſcles, with long and very delicate tendons. Their fleſhy bellies are about the length of the metacarpal bones, and their ſmall tendons ſtretch over two joints, to reach the middle of the ſecond phalanx. The firſt lumbricalis is larger than the ſecond, and the two firſt larger than the two laſt.

The firſt ariſes from the ſide of the tendon of the fore fingers, which is next to the radius; the others ariſe in the forks of the tendons; and though they riſe

more

more from that tendon which is next the ulna, yet they have attachments to both. Their tendons begin below the firſt joint of each finger; they run very ſlender along the firſt phalanx, and they gradually wind around the bone, ſo that though the muſcles are in the palm of the hand, the tendons are implanted in the back parts of the fingers, and their final connection is not with the bending tendons of the ſublimis and profundus, but with tendons of the extenſor digitorum, and with the tendons of the external interoſſei muſcles, with which they are united by tendinous threads.

Hence their uſe is very evident; they bend the firſt joint, and extend the ſecond; they perform alternately either office; when the extenſors act, they aſſiſt them by extending the ſecond phalanx or joint: when the flexors act, and keep the firſt and ſecond joint bended, the extending effect of theſe ſmaller muſcles is prevented, and all their contraction muſt be directed, ſo as to affect the firſt joint only, which they then bend.

They are chiefly uſeful, in performing the quick ſhort motions, and ſo they are named by Cowper, the muſculi fidicinales, as chiefly uſeful, in playing upon muſical inſtruments.

XC. The FLEXOR LONGUS POLLICIS is placed by the ſide of the ſublimis, or perforatus, and lies under the ſupinator and flexor carpi radialis. It runs along the inner ſide of the radius, whence chiefly it ariſes.

Its origin is from all the internal face of the radius downwards, from the place where the biceps is inſerted, and from the interoſſeous ligament, all the length down to the origin of the pronator quadratus; nor does it even ſtop here; for the tendon continues to receive fleſhy ſlips all the way down to the paſſage under the ligament of the wriſt. It has often alſo another head, which ariſes from the condyle of the humerus, and the fore part of the ulna; which head is tendinous, and joins that origin which comes from the radius.

The muſcle becomes again tendinous, very high, i. e. above the middle of the arm; and its ſmall tendon paſſes under the annular ligament, glides in the hollow

of

of the os metacarpi pollicis, and ſeparates the ſhort flexor into two heads, paſſes betwixt the two ſeſamoid bones in the firſt joint of the thumb, and running in the tendinous ſheath, it reaches at laſt the end of the fartheſt bone of the thumb, to be inſerted into the very point of it.

There is ſometimes ſent off from the lower part of the muſcle a ſmall fleſhy ſlip, which joins its tendons to the indicator tendon of the ſublimis.

Its uſes, we conjecture, are exactly as of thoſe of the other flexors, to bend the laſt phalanx on the firſt, the firſt on the metacarpal bones, and occaſionally the wriſt upon the radius and ulna.

XCI. The PRONATOR QUADRATUS, ſo named from its ſhape and form, is one of the moſt ſimple in its action, ſince it ſerves but one direct purpoſe, viz. turning the radius upon the ulna.

It lies flat upon the interoſſeous ligament, upon the fore part of the arm, about two inches above the wriſt; it is nearly ſquare, and is about three inches in length and breadth. Its fibres go obliquely acroſs, betwixt the radius and ulna. It ariſes from the edge of the ulna, adheres to the interoſſeous ligament, and goes to be implanted into the edge of the radius; it turns the radius upon the ulna. This muſcle, and in ſome degree alſo the flexor pollicis, are the only muſcles which do not come fairly under that arrangement, by which I have endeavoured to explain the muſcles of the fore-arm.

EXTENSORS.

The muſcles which lie upon the outer ſide of the fore-arm, the ſupinators and the extenſors of the fingers and wriſt, all ariſe from one point, the external condyle of the humerus, and are all delivered in this liſt:

The EXTENSOR CARPI RADIALIS LONGIOR, The EXTENSOR CARPI RADIALIS BREVIOR, The EXTENSOR CARPI ULNARIS,	all extend the wriſt.

The

The SUPINATOR LONGUS, — turns the palm upwards.

The EXTENSOR COMMUNIS DIGITORUM, — extends all the fingers, and unfolds the hand.

The EXTENSOR PRIMI INTERNODII POLLICIS,
The EXTENSOR SECUNDI INTERNODII POLLICIS,
The EXTENSOR TERTII INTERNOIDII POLLICIS,
} extend the ſeveral joints of the thumb.

The EXTENSOR PRIMI DIGITI vel INDICATOR, — extends the fore finger.

The EXTENSOR MINIMI DIGITI, vel AURICULARIS, — extends the little finger.

All theſe muſcles ariſe from one point, the external condyle. They all roll the radius outwards, or extend the wriſt, or extend the fingers. As the muſcles which are bent, need more fibres, and greater ſtrength, they ariſe from the internal condyle, which is the larger; they lie in a deep hollow, for the bones of the fore-arm are bent to receive them, and they form a very thick fleſhy cuſhion: but the extenſors requiring leſs power, ariſe from the ſhorter proceſs of the outer condyle, are on the convex ſide of the arm, and are thin, having few fibres; for though there is a large maſs of fleſh on the inner ſide of the arm, forming two big flexors, there is only a thin layer on the outer ſide of the arm, forming one flat and weak extenſor.

XCII. SUPINATOR RADII LONGUS. This muſcle forms the very edge of the fore-arm: it ariſes by many ſhort tendinous fibres, from the ridge of the humerus, above the external condyle, which origin is fully two inches in length above the condyle. It alſo ariſes from the intermuſcular membrane; and, as it ſtands on the very edge of the fore-arm, it runs betwixt the flexor and extenſor radialis. It becomes thicker as it paſſes the joint of the humerus, and there gives a very peculiar form to the arm: it then becomes ſmaller, and forms a flat tendon, which is quite naked of fleſh from the middle of the radius, or a little below, down to the wriſt. This tendon becomes gradually ſmaller, till

it

it reaches the wriſt, where expanding a little, it is inſerted into the radius, juſt in the tuber of its lower head.

Its uſe is, perhaps, chiefly as a ſupinator, but it is placed juſt upon the edge of the arm; it ſtands as a ſort of intermedium betwixt the two ſets of muſcles; it is fixed, indeed, rather upon the internal ſurface of the radius; but yet when the ſupination is complete, when the hand is rolled very much outward, it will become a pronator.

It is at once ſupinator and pronator, and for a moſt evident reaſon, a flexor alſo of the fore-arm, ſince its origin is at leaſt two inches up the humerus, above the joint of the elbow.

XCIII. The EXTENSOR CARPI RADIALIS LONGIOR, has the additional name of longior or primus, to diſtinguiſh it from the next. It is almoſt entirely covered with the laſt muſcle, the ſupinator.

It ariſes from the ridge of the humerus above the external condyle, and juſt under the origin of the ſupinator; it deſcends all along the back of the radius; and after having become a thick fleſhy belly, it degenerates a little lower than the middle of the radius, into a thin flat tendon, which becomes ſlender and ſmall as it deſcends; and turning a little more towards the back of the radius, it then paſſes over the wriſt, and goes along with the tendon of the extenſor, under the annular ligament, paſſing in a groove of the radius; at laſt, it is inſerted into the root of the metacarpal bone of the fore finger, in that edge next the thumb.

It is chiefly an extenſor of the wriſt: in pronation, it pulls the wriſt directly backwards; in ſupination, it moves the hand ſideways. It is alſo a pronator, when the hand is turned back to the greateſt degree; and from its origin, high upon the arm-bone; it is alſo a flexor of the fore arm.

XCIV. EXTENSOR CARPI RADIALIS BREVIOR. This muſcle is almoſt the ſame in deſcription, name, and uſe, with the former. It ariſes from the external condyle; and here a common tendon for many muſcles is formed,

formed, juſt as in the internal condyle; for from this point ariſe the extenſor carpi radialis brevior, extenſor digitorum, tenſor minimi digiti, extenſor carpi ulnaris.

The extenſor carpi radialis brevior ariſes from the outer condyle of the humerus, by the common tendon; it alſo ariſes from the aponeuroſis, which lies betwixt the extenſor digitorum and this; it grows a pretty large, fleſhy body, and begins like the laſt, to be tendinous below the middle of the radius; ſo that this muſcle continues fleſhy lower than the laſt one, and its tendon is alſo much larger and thicker; it runs under the annular ligament, in the ſame channel with the extenſor longior; it expands a little before its inſertion, which is into the back part of the metacarpal bone of the middle finger, a little towards that edge which is next the radius: ſome little fibres paſs from this tendon to the metacarpal bone of the fore finger.

All that was ſaid concerning the extenſor longus, may be ſaid of this; for all the three laſt muſcles, lie ſo ambiguouſly on the edge of the arm, that though they are regularly ſupinators and extenſors, they become pronators and flexors, in certain poſitions of the hand.

XCV. Extensor carpi ulnaris. — By the name merely of this muſcle, we know its extent and courſe, its origin, inſertion, and uſe.

It is one of the muſcles, which belong to the common tendon, ariſing from the external tubercle of the os humeri: it lies along the ulnar edge of the arm; it alſo ariſes from the intermuſcular membrane, which ſeparates this from the extenſor digitorum and the extenſor digiti minimi; and chiefly it is attached to the internal ſurface of the common ſheath. It ariſes alſo from the face and edge of the ulna, the whole way down; its tendon begins in the middle of its length, and is accompanied all down to the wriſt with feather-like fleſhy fibres.

It is fixe[illegible] into the outſide of the lower head of the metacarpal bone of the little finger.

Its

Its uſe is to extend the carpus. And it may be now obſerved, that when the two extenſors of the wriſt, the radialis and ulnaris act, the hand is bent directly backwards; that when the flexor radialis and extenſor radialis act together, they bend the thumb towards the radius; and that when the flexor ulnaris and extenſor ulnaris act, they draw down the ulnar edge of the hand.

XCVI. Extensor digitorum communis.—This muſcle correſponds with the ſublimis and profundus, and antagoniſes them, and reſembles them in ſhape as in uſe. It covers the middle of the fore-arm at its back, and lies betwixt the extenſor radialis ſecundus, and the extenſor minimi digiti.

Its origin is chiefly from the outer condyle, by a tendon common to it, with the extenſor carpi radialis brevior; it comes alſo from the intermuſcular membrane, which ſeparates it on one ſide from the extenſor minimi digiti, and on the other from the extenſor carpi brevior, and laſtly, from the back part of the common ſheath. It grows very fleſhy and thick, as it deſcends, and about the middle of the fore-arm it divides itſelf into three ſlips of very equal ſize. But though the tendons begin ſo high they continue like thoſe of the flexors, to receive fleſhy penniform fibres all down, almoſt to the annular ligament. Theſe tendons are tied together by a looſe web of fibres, and being gathered together they paſs under the ligament in one common and appropriated channel. Having paſſed this ligament they diverge and grow flat and large. And they all have the appearance of being ſplit by a perpendicular line. They are quite different from the flexor tendons in this, that they are all tied to each other by croſs bands; for a little above the knuckles, or firſt joint of the fingers, all the tendons are joined on the back of the hand by ſlips from the little finger to the ring, from the ring to the mid finger, and from that to the fore finger. So that it ſeems to be one ligament running quite acroſs the back of the hand. It would be fooliſh to deſcribe them

them more minutely: for the croſs bands change their places, and vary in every ſubject, and in ſome they are not found.

After this, the tendons paſs over the heads of the metacarpal bones, along the firſt phalanx of the fingers, and being there joined by the tendons of the interoſſei and lumbricales, they all together form a ſtrong tendinous ſheath, which ſurrounds the back of the fingers.

Now it is to be remembered, that this muſcle ſerves only for the fore, middle, and ring fingers: that if it moves the little finger, it is only by a ſmall ſlip of tendinous fibres, which it often gives off at the general divergence, but ſometimes not; ſometimes it gives one ſlip, ſometimes two, often none at all. And ſo the little finger has its proper extenſor quite diſtinct from this.

The uſe of the muſcle is to extend all the fingers; and when they are fixed, it will aſſiſt the extenſors of the wriſt, as in ſtriking backwards with the knuckles.

XCVII. The EXTENSOR MINIMI DIGITI, named alſo AURICULARIS, from its turning up the little finger, as in picking the ear, ſhould really be deſcribed with the laſt muſcle; if we ſee the origin, courſe, and uſe of this muſcle exactly the ſame with it, why ſhould we not reckon it as a ſlip of the common extenſor, appropriated to the little finger?

Its origin is from the outer condyle, along with the other tendons. It alſo adheres ſo cloſely both to the tendinous partitions, and to the internal ſurface of the common faſcia, that it is not eaſily ſeparated in diſſection. It begins ſmall, with a conical kind of head; it gradually increaſes in ſize; it is pretty thick near the wriſt; it adheres all along to the common extenſor of the fingers; it begins to be tendinous about an inch above the head of the ulna; it continues to receive fleſhy fibres down to the annular ligament; and it paſſes under the annular ligament, in a channel peculiar to itſelf, which is indeed the beſt reaſon for making this a diſtinct muſcle.

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This channel has a very oblique direction, and the tendon, like all the others, expands greatly in escaping from the ligament of the wrist. It is connected with the other tendons, in the manner I have described. Close to the wrist, it is connected with the tendon of the ring finger, by a slip which comes from it; and at the knuckle, and below it, it is again connected with the tendons both of the ring finger, and of all the others, by the cross bands or expansions.

Whatever has been said of the use of the last muscle, is to be understood of this; as its extending its proper finger, assisting the others by its communicating band, and in its extending the wrist, when the fist is clenched. Its insertion is into the back of the second joint of the little finger, along with the interossei and lumbricales. Its tendon has also a small slit; for the head of the proper extensor of the little finger, and the heads of the common extensors of the others, are inserted into the top of the second phalanx, just under the first joint. They send off at the sides tendinous slips, which, passing along the edges of the bones, do, in conjunction with the tendons of the interossei and lumbricales, form a split tendon, which meets by two curves at the foot of the last bone of the fingers, to move the last joint.

XCVIII. The EXTENSOR PRIMUS POLLICIS is the shortest of the three. It is named by Albinus, and others, ABDUCTOR LONGUS; but since every muscle that extends the thumb must pull it away from the hand, every one of them might be, with equal propriety, named abductors.

The extensor primus lies just on the fore edge of the radius, crossing it obliquely.

It arises about the middle of the fore-arm, from the edge of the ulna, which gives rise to the interosseous membrane itself, and also from the convex surface of the radius.

The fleshy belly commonly divides itself into two or three, sometimes four fleshy slips, with distinct tendons, which, crossing the radius obliquely, slip under the external

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ternal ligament of the carpus, and are implanted into the root of the firſt metacarpal bone, or rather of the firſt phalanx of the thumb, towards the radial edge, ſo that its chief uſe is to extend the thumb, and to incline it a little outwards towards the radius. It muſt alſo, like the extenſors of the fingers, be an extenſor of the wriſt: and it evidently muſt, from its oblique direction, aſſiſt in ſupination.

XCIX. The EXTENSOR SECUNDUS POLLICIS is longer than the firſt. It is named by Douglas, the extenſor ſecundi internodii pollicis; by Albinus, the extenſor minor pollicis.

This muſcle lies cloſe by the former. It ariſes juſt below it, from the ſame edge of the radius, and from the ſame ſurface of the interoſſeous membrane, it runs along with it in the ſame bending courſe; and, in ſhort, it reſembles it ſo much, that Winſlow has reckoned it as part of the ſame muſcle.

Its origin is from the edge of the ulna, the interoſſeous ligament, and the radius. Its ſmall round tendon paſſes ſometimes in a peculiar channel, ſometimes with the extenſor primus. It goes over the metacarpal bone of the thumb; it expands upon the bone of the firſt phalanx; aud it is inſerted juſt under the ſecond joint.

It extends the ſecond bone of the thumb upon the firſt; it extends the firſt bone alſo; and it extends the wriſt, and, by its oblique direction, contributes to ſupination.

C. EXTENSOR TERTIUS POLLICIS. — This which bends the third joint is called in common the extenſor longus pollicis. And here is a third muſcle, which in form and place, and function, correſponds with the two former ones,

Its origin is from the ridge of the ulna, and from the upper face of the interoſſeous membrane; and it is a longer muſcle than the others, for it begins high, near the top of the ulna, and continues the whole way down that bone, and is very fleſhy and thick. It is penniform all the way down to the ligament of the wriſt; and its

ſmall tendon paſſes the ligament in a peculiar ring. This tendon appears ſplit, like thoſe of the fingers; it goes along the ulnar ſide of the firſt bone of the thumb, reaches the ſecond, and is implanted there by a ſmall ſlip of tendon; and being expanded, it ſtill goes forward, to be inſerted once more into the third bone of the thumb at its root.

Its uſe is evident, after deſcribing the others. For we have only to add another joint for motion. It moves the laſt joint of the thumb, then the ſecond, then its metacarpal bone upon the carpus; and if that be held firm, it will extend the carpus; and it will, in its turn, contribute to ſupination, though in a leſs degree than the others.

CI. INDICATOR. — The EXTENSOR INDICIS PROPRIUS has very nearly the ſame origin, and exactly the ſame courſe with the laſt, and lies by the ſide of it.

Its origin is from the ulna, by the ſide of the extenſor longus pollicis. It has alſo ſome little attachments to the interoſſeous membrane. It, like the others, is feathered with fibres, in an oblique direction, down to the ligament of the wriſt.

This muſcle lies under the extenſor communis digitorum: its tendon paſſes along with the common tendon, through the annular ligament; and near the top of the metacarpal bone, or about the place of the common junctions of all theſe tendons, this one joins with the indicator tendon of the common extenſor.

Its uſe is in extending all the three joints of the fore-finger; aſſiſting the common extenſor in pointing with that finger; in acting independently of the common extenſor; and in helping to extend the wriſt, when the fingers are cloſed.

CII. The SUPINATOR BREVIS is an internal muſcle, which forms, with the muſcles of the thumb, and of the fore-finger, a kind of ſecond layer; and this one lies concealed, much as the pronator quadratus does, on the inner ſide of the fore-arm. It is a ſhort muſcle, but very thick and fleſhy, and of great power.

It arifes from the outer tubercle of the os humeri, and from the edge of the ulna, and from the interoffeous ligament: it is then lapped over the radius, and is inferted into its ridge; fo that this fupinator brevis is very directly oppofed to the pronator teres, the infertion of the two mufcles, almoft meeting on the edge of the radius. It is almoft circumfcribed to one ufe, that of performing the rotation of the radius outwards; but, perhaps, it may alfo have fome little effect in extending the ulna and of affifting the anconeus.

MUSCLES SEATED ON THE HAND.

BESIDES thefe mufcles which bend and extend the fingers, there are other fmaller ones feated on the hand itfelf, which are chiefly for affifting the former, and for quicker motions; but moft efpecially for the lateral motions of the thumb and little finger, and which are therefore named ADDUCTORS, ABDUCTORS, and FLEXORS, of the little finger and thumb.

That they are chiefly ufeful in affifting and ftrengthening the larger mufcles, is evident from this, that much power being required for flexion, we find many of thefe fmaller mufcles, added in the palm of the hand; but as there is little power of extenfion needed, no more almoft, than to balance the power of the flexors, there are no fmall mufcles on the back of the hand, the interoffei externi excepted, which are chiefly ufeful in fpreading the fingers.

The fhort mufcles in the palm of the hand are for bending the thumb, the fore-finger and the little finger; and the little finger and the thumb have each of them three diftinct mufcles; one to pull the thumb away from the hand, one to bend it, and one to pull it towards the hand, oppofing it to the reft of the fingers, and fo of the little finger, which has alfo three mufcles.

ARRANGEMENT OF THESE MUSCLES.

1. LUMBRICALES, which bend all the fingers.
2. ABDUCTOR POLLICIS, removing the thumb from the fingers.
3. FLEXOR AND OPPONENS POLLICIS, ADDUCTOR POLLICIS, carrying the thumb towards the palm, as in grafping.
4. ABDUCTOR INDICIS, which carries the fore finger towards the thumb.
5. ABDUCTOR MINIMI DIGITI, ADDUCTOR MINIMI DIGITI, FLEXOR MINIMI DIGITI, which bend the little finger, and carry it, like the thumb, outwards or inwards.
6. INTEROSSEI, which are fmall mufcles, lying betwixt the metacarpal bones, and affifting the lumbricales in bending the fingers, and perform the lateral motions of the fingers.

All the mufcles of the thumb are feated on the infide, to form the great ball of the thumb; and it is not eafy at firft to conceive how mufcles having fo much the fame place fhould perform fuch oppofite motions; yet it is eafily explained, by the flight variation of their places; for the ABDUCTOR arifes from the annular ligament near the radius, and goes towards the back of the thumb.

The flexors arife deeper, from bones of the carpus, and from the infide of the ligament, and go to the infide of the thumb. The ADDUCTOR arifes, from the metacarpal of the mid-finger, and goes to the inner edge of the thumb.

CIII. The ABDUCTOR POLLICIS is only covered by the common integuments. It begins a little tendinous from the outfide of the annular ligament, juft under the thumb, and by fome little fibres from the os fcaphoides; and, from the tendon of the long abductor or extenfor primus, it bends gradually round the thumb, and is at laft inferted in the back of the firft joint, juft above the head

head of the metacarpal bone. But it does not ſtop here; for this flat tendon is now expanded into the form of a faſcia, which ſurrounding the firſt bone of the thumb, goes forward upon its back part, quite to the end, along with the common tendon of the extenſor. This muſcle, like the others, is covered by a thin expanſion from the tendon of the palmaris, as well as by the common integuments.

Its only uſe is to pull the thumb from the fingers, and to extend the ſecond bone upon the firſt.

Albinus deſcribes a ſecond muſcle of the ſame name, having the ſame courſe, origin, inſertion, and uſe: it alſo ariſes from the outer ſide of the ligament of the wriſt, and is fixed into the ſide of the thumb, and lies upon the inſide of the former muſcle.

Theſe two are inſerted into the firſt bone of the thumb; but the next is inſerted into the metacarpal bone.

CIV. The OPPONENS POLLICIS, is often called the metacarpal of the thumb. It is placed on the inſide, and implanted into the ſide of the thumb: its office is to draw the thumb acroſs the other fingers, as in clenching the fiſt; and from its thus oppoſing the fingers it has its name of opponens.

It lies immediately under the laſt deſcribed muſcle, and is like it in all but its inſertion.

It ariſes from the os ſcaphoides, and from the ligament of the wriſt. It is inſerted into the edge and fore-part of the metacarpal bone of the thumb: and its uſe is to turn the metacarpal bone upon its axis, and to oppoſe the fingers; or, in other words, to bend the thumb: for I can make no diſtinction. Therefore, this muſcle and the next, which lies cloſe upon it, may be fairly conſidered as but two different heads of one thick ſhort muſcle.

CV. The FLEXOR BREVIS POLLICIS is a two-headed muſcle, placed quite on the inſide of the thumb, betwixt the fore-finger and the thumb, and extends obliquely acroſs the two firſt metacarpal bones. It is divided

divided into two heads by the long flexor of the thumb.

The edge of this muſcle lies in cloſe contact with the edge of the laſt, or opponens; and indeed they may fairly be conſidered as one large muſcle ſurrounding the baſis of the thumb.

One head ariſes from the os trapezium, or baſe of the thumb, and from the ligament of the wriſt. The other head comes from the os magnum, from many of the other bones of the carpus, and from the ligaments which unite them.

The firſt head is the ſmaller one: it terminates by a pretty conſiderable tendon in the firſt ſeſamoid bone. The ſecond head runs the ſame courſe: it is implanted chiefly in the ſecond ſeſamoid bone, and alſo into the edge of the firſt bone of the thumb cloſe by it. The ſecond head is exceedingly muſcular and ſtrong: the heads are completely ſeparated from each other by the tendon of the flexor longus paſſing betwixt them.

The office of this muſcle is to bend the firſt joint upon the ſecond, and the metacarpal bone upon the carpus: and indeed the office of this, and of the opponens, is the ſame. It is in the tendons of this double-headed muſcle that the ſeſamoid bones are found.

CVI. The ADDUCTOR POLLICIS ariſes from the metacarpal bone of the middle finger, where it has a flat extended baſe. It goes from this directly acroſs the metacarpal bone of the fore-finger to meet the thumb. It is of a triangular ſhape, and flat: its baſe is at the metacarpal bone; its apex is at the thumb: it is inſerted into the lower part or root of the firſt phalanx: its edge ranges with the edge of the flexor brevis: it concurs with it in office; and its more peculiar uſe is to draw the thumb towards the fore-finger, as in pinching.

Thus, do theſe muſcles, covering the root of the thumb, form that large ball of fleſh which acts ſo ſtrongly in almoſt every thing we do with the hand.

The

The ball of the thumb is fairly ſurrounded; it is almoſt one maſs, having one office: but as the deltoides, will, in ſome circumſtances, pull the arm downwards, ſome portions of this fleſhy maſs pull the thumb outwards obliquely; ſome directly inwards: but the great maſs of muſcle bends the thumb, and oppoſes it to the hand: and as this one muſcle is to oppoſe the whole hand, the ball of fleſh is very powerful and thick.

The ſhort muſcles of the little finger ſurround its root, juſt as thoſe of the thumb ſurround its ball.

CVII. The ABDUCTOR MINIMI DIGITI is a thin fleſhy muſcle, which forms the cuſhion on the lower edge of the hand, juſt under the little finger. It is an external muſcle: it ariſes from the os piſiforme, and from the outer end of the annular ligament. It is inſerted laterally into the firſt bone of the little finger; but a production of it ſtill goes forward to the ſecond bone of the little finger.

Its uſe is to ſpread the little finger ſideways, and perhaps to aſſiſt the flexors.

CVIII. The FLEXOR PARVUS MINIMI DIGITI is a ſmall thin muſcle which riſes by the ſide of the laſt, and runs the ſame courſe, with nearly the ſame inſertion.

Its origin is from the ligament of the wriſt, and in part from the crooked proceſs of the unciform bone. Its uſe is to bend the little finger. And indeed the office and place of both is ſo much the ſame, that I have marked the laſt as a flexor; the litttle difference there is, is only that this performs a more direct flexion.

CIX. The ADDUCTOR MINIMI DIGITI is ſometimes called the metacarpal of the little finger. It lies immediately under the former muſcle. Its origin is from the hook of the unciform bone, and the adjoining part of the carpal ligament.

It is inſerted into the outſide of the metacarpal bone, which it reaches by turning round it. Its uſe is to put the little finger antagoniſt to the others: it is to

to this finger what the opponens is to the thumb. It also, by thus bending one bone of the metacarpus, affects the whole, increases the hollow and external convexity of the carpus, and forms what is called Diogenes's cup.

CX. The ABDUCTOR INDICIS is a flat muscle of considerable breadth, lying behind the adductor pollicis, and exactly resembling it, being like the second layer. It arises from the os trapezium, and from the first bone of the thumb; and it is inserted into the back part of the first bone of the fore-finger, and pulls it towards the thumb.

The INTEROSSEI are situated betwixt the metacarpal bones. They are small, round, and neat, something like the lumbricales in shape and size, and in office resemble the adductors and abductors. Three are found in the palm which bend the fingers, and draw their edges a little towards the thumb; four are found on the back of the hand, for extending the fingers; they at at the same time perform the lateral motions of the fingers.

CXI. The INTEROSSEI INTERNI arise from betwixt the metacarpal bones. They are also attached to the sides of these bones. They send their tendons twisting round the sides to the backs of these bones. And they are inserted along with the tendons of the lumbricales and extensors, into the back of the finger. They are thus flexors of the first joint, and extensors of the second joint, as the lumbricales are.

CXII. The INTEROSSEI EXTERNI are four in number. They arise, like the interni, from the metacarpal bones and their interstices, and from the ligaments of the carpal bones. They are peculiar in having each two heads, therefore named interossei bicipites. They join their tendons to those of the extensor and lumbricales; they have therefore one common office with them, that is, extending all the joints of the fingers. Many have chosen to describe the origin and insertion with most particular care, marking the degree of obliquity, and ascertaining precisely their office, and giving particular

names to each, as prior indicis for the firſt external; all which I forbear mentioning, becauſe they muſt be more liable to perplex than aſſiſt: if we but remember their common place and office, it is enough. The tendons of the flexor muſcles bend round the finger, along with the interoſſei and lumbricales, for a ſurer hold; conſequently the tendons of the lumbricales, of the interoſſei interni, of the extenſors, and of the interoſſei externi, meet upon the backs of the fingers, which are by them covered with a very ſtrong web of tendinous fibres.

CHAP. IV.

MUSCLES OF RESPIRATION; OR, OF THE RIBS.

THE whole back is clothed with ſtrong muſcles, and all its holes, irregularities, and ſpines, are croſſed with many ſmaller ones. Theſe muſcles are related either to the arm, to the ribs, or to the ſpine, i. e. the vertebræ, whoſe motions they perform; and from this we obtain an arrangement not inconſiſtent with the regular order of their office, and yet correſponding with the beſt order of diſſection.

The firſt, or uppermoſt layer of muſcles, viz. the trapezius, the muſculus patientiæ, the rhomboides, the latiſſimus dorſi, belong to the arm. The ſerrated muſcles which lie next under theſe, are the muſcles of reſpiration, and belong to the ribs; while the ſplenius and complexus, the muſcles of the neck, the longiſſimus dorſi, ſacro lumbalis, and the quadratus lumborum, which are muſcles of the back, and the innumerable ſmaller muſcles which lie betwixt the vertebræ, belong entirely to the ſpine.

Reſpiration is indeed performed chiefly by the muſcles of the belly, that is, in ordinary and eaſy breathing. In high breathing, the difficulty is relieved by the co-operation

operation of almoſt all the muſcles of the trunk, of which there is ſcarcely one that may not aſſiſt in ſome ſlight degree. But yet the muſcles of the abdomen have many other offices. And the muſcles of the ſpine, and of the ſcapula, again belong properly to the arm and trunk, and therefore I call thoſe the muſcles of reſpiration, by which the ribs are moved in breathing, and which have no direct relation to almoſt any other motion, but merely that of the ribs.

The muſcles which are appropriated to the ribs, performing no other motion, are,

1. The SERRATUS POSTICUS SUPERIOR,	which comes from the neck, and lies fleſhy over the ribs, to pull them upwards.
2. The SERRATUS INFERIOR POSTICUS,	which comes from the lumbar vertebræ, and lies flat on the lower part of the back, to pull the ribs downwards.
3. The LEVATORES COSTARUM,	which are twelve flat muſcles ariſing from the tranſverſe proceſs of each vertebra, and going down to the rib below, they raiſe the ribs.
4. The INTERCOSTAL MUSCLES,	which lie betwixt the ribs, and fill up all the ſpace betwixt rib and rib; they alſo raiſe the ribs.

And there may be added to theſe, that muſcle, which, lying under the ſternum, and within the thorax, is called triangularis ſterni, and pulls the ribs downwards.

CXIII. The SERRATUS SUPERIOR POSTICUS lies flat upon the ſide of the neck, under the trapezius and rhomboides, and over the ſplenius and complexus muſcles. It ariſes by a flat and ſhining tendon from the ſpines of the three lower vertebræ of the neck, and the

two

two uppermoſt of the back. It goes obliquely downwards under the upper corner of the ſcapula, and is inſerted into the ſecond, third, and fourth ribs, by three neat fleſhy tongues.

The ligamentum nuchæ is chiefly formed by the meeting of the trapezii muſcles; but the flat tendons of theſe upper ſerrated muſcles help to form it.

They are purely levators of the ribs; their effect upon the vertebræ, if they have any, muſt be very ſlight.

CXIV. The SERRATUS INFERIOR POSTICUS, is a very broad thin muſcle, ſituated at the lower part of the back, under the latiſſimus dorſi, or over the longiſſimus dorſi muſcle.

It ariſes in common with the latiſſimus dorſi, from the ſpines of the two or three lower vertebræ of the back, and the three or four uppermoſt vertebræ of the loins. Their origin, like that of the latiſſimus, is by a thin tendinous expanſion; it ſoon becomes fleſhy, and, dividing into three, ſometimes four fleſhy ſtraps or tongues, each of them is inſerted ſeparately into the ninth, tenth, eleventh, twelfth lower ribs, near their cartilages. So that this muſcle, ſpreading ſo wide out from the centre of motion, has vaſt power; for it has the whole length of the rib as a lever.

The office of it is to pull the ribs downwards and backwards, the effect of which muſt be to compreſs the cheſt, and in certain circumſtances to turn the ſpine.

CXV. The LEVATORES COSTARUM are twelve muſcles on each ſide, for the direct purpoſe of raiſing the ribs; they lie above or upon the ribs, at their angles, and are thence named, by ſome, SUPRA COSTALES.

They are almoſt a portion of the external intercoſtal muſcles. The firſt of the levators, ariſes from the tranſverſe proceſs of the laſt vertebra of the neck, and goes down to be inſerted into the firſt rib, near its tuberoſity; and ſo all that follow ariſe from a tranſverſe proceſs, and go to the rib below, being very

ſmall

ſmall and tendinous at either end; but the three laſt levators, ariſe from the ſecond proceſs above the rib to which they belong: they paſs one rib to go into the one below it; they are conſequently twice as long as the nine firſt are, and are therefore named LEVATORES COSTARUM LONGIORES, from the ninth downwards.

Thus, the levatores coſtarum are a ſucceſſion of ſmall muſcles, ariſing from the tranſverſe proceſſes of the vertebræ, and going to the angles of the ribs, beginning from the laſt vertebra of the neck, and ending with the laſt but one of the back. They lie under the longiſſimus dorſi, and ſacro-lumbalis; and often they have connections with theſe muſcles, ſometimes very cloſe.

They run obliquely from the lower edge of one rib, downward and forward, or in a direction from behind forward, to be inſerted into the upper edge of the rib below; the muſcle is not continued into the ſpace betwixt the cartilages of the ribs. The internal again are perfect betwixt the cartilages of the ribs, but they proceed no further back than the angles of the ribs. They are further different from the internal muſcles, inaſmuch as they paſs obliquely backward and downward from the margin of the one rib to the other.

Theſe two rows were thought to antagonize each other; the one to pull the ribs downwards, the other to raiſe them; but I ſhall not ſtop to explain this, nor to refute it; it is ſufficient to declare their true uſe, which is (both external and internal) to raiſe the ribs and aſſiſt inſpiration *.

The ninth, tenth, eleventh, and twelfth ribs, have a freer motion; and it appears to me that this is the true reaſon of the levatores longiores; and for the ſame reaſon, we find, that from the ſixth rib and downwards, there are certain ſlips of the internal intercoſtals, which paſs over one rib, and go to the ſecond below; and as

* I remember many years ago, to have heard Dr. Monro explain the office of the intercoſtal muſcles by a diagram, deducing from that argument, the more powerful effect of all muſcles having oblique fibres.

the

the levatores longiores were called ſupra-coſtales, theſe have been named INFRA-COSTALES, and COSTARUM DEPRESSORES PROPRII. They were diſcovered by Verhein, and bear his name; they were explained as depreſſors of the ribs, by Haller, but they are little different from the intercoſtals in form, and not at all in office, for they raiſe the ribs, along with the intercoſtal muſcles.

CXVII. The TRIANGULARIS STERNI, or STERNO COSTALIS, is a depreſſor of the ribs; an internal muſcle lying chiefly on the inner face of the ſternum, and the cartilages of the ribs. It is very generally conſidered as a triangular muſcle on each ſide, but ſome conſider it as three or four muſcles, under the title of ſterno-coſtales.

There are four ſlips lying on the cartilages of the third, fourth, fifth, and ſixth ribs. The lower portion of the triangularis ariſes from the enſiform cartilage, and is inſerted into the third or fourth rib; the third ariſes from the middle of the ſternum, and goes off from the edges of that bone, to be inſerted into the third rib.

The fourth or uppermoſt portion is often wanting; it goes off in part, alſo from the inner ſurface of the ſternum, but more commonly from the third rib, and goes to the ſecond rib.

In a dog they are much larger than in a man. Their office is to depreſs the ribs; and theſe portions are all conjoined at their roots, which gives the whole muſcle the triangular ſhape.

The true uſes of the intercoſtales, ſubcoſtales, and triangularis ſterni, have been diſputed; but if the firſt rib be more fixed than the other ribs, then the intercoſtals proceeding downwards, from the firſt rib, muſt raiſe all the thorax; and if the ſternum be more fixed than the ribs, then the ſterno-coſtales muſcles going upwards from the ſternum, muſt pull down the ribs.

CHAP.

CHAP. V.

MUSCLES OF THE HEAD, NECK, AND TRUNK.

THE ſerratus ſuperior poſticus being raiſed, the ſplenii come into view, and the ſplenii being alſo lifted, the complexus is fully expoſed.

CXVIII. SPLENIUS. — The two ſplenii are ſo named, from their lying like ſurgical ſplints, along the ſide of the neck; both together, they have the appearance of the letter Y; the complexus being ſeen betwixt them in the upper part of the angle. They lie immediately under the trapezii, and above the complexi.

Each ſplenius is a flat and broad muſcle, which ariſes from the ſpinous proceſſes of the neck and back, and is implanted into the back part of the head. It ariſes from the four upper ſpines of the back, and the five lower of the neck; it parts from its fellow at the fifth vertebra of the neck, ſo as to ſhew in the interſtice two or three of the uppermoſt ſpines of the neck, with the upper part of the complexus muſcle; each ſplenius goes obliquely outwards to be inſerted into the occipital ridge, and all along to the root of the maſtoid proceſs. At the third vertebra of the neck, where the two ſplenii muſcles part from each other, the tendons of the oppoſite ſplenii are cloſely connected both with each other, and with the common tendon, which is called ligamentum nuchæ.

This is the SPLENIUS CAPITIS; but there is a portion of this ſame muſcle which lies under this, and which has the ſame common origin, but which terminates by four or five diſtinct tendons, in the tranſverſe proceſſes of the upper vertebræ of the neck. This portion may be diſſected apart, and has been conſidered by many as a muſcle, the SPLENIUS COLLI of Albinus; who has diſtinguiſhed as ſplenius capitis all that part ariſing from the ſpines of the neck, and implanted into the head; and as the ſplenius colli, all that part which ariſes

arises from the vertebræ of the back, and is implanted into the transverse processes of the neck.

These splenii are the right antagonists of the mastoid muscles; both the splenii acting, pull the head directly backwards; one acting turns the head and neck obliquely to one side; one acting along with the corresponding mastoid muscle, lays the ear down upon the shoulder.

CXIX. The COMPLEXUS is named from the intricacy of its muscular and tendinous parts, which are mixed; from the irregularity of its origins, which are very wide, it has the names of COMPLEXUS IMPLICATUS TRIGEMINUS, by which the student is warned of the difficulty of understanding this muscle.

It lies immediately under the splenius; arises by distinct tendons, with ten or more tendinous feet, from the four lower transverse processes of the vertebræ of the neck, and from the seven uppermost of the back; having also some less regular origins, as from two spines of the back, and from four oblique processes in the neck. It grows into a large muscle, which is not like the splenius, flat and regular, but thick, fleshy, composed of tendon and flesh mixed, filling up the hollow, by the sides of the spines of the neck, and terminating in a broad fleshy head, which is fixed under the ridge of the occipital bone; and this is the part which is seen in the angle or forking of the splenii.

This may stand as the general description of the muscle considered as one. But Albinus has chosen to describe it as two muscles, under two different names, with a minuteness which, far from clearing the demonstration of any difficulties, makes it less distinct; and, if any thing could complete the confusion, it was his humour of calling that BIVENTER, which had been hitherto named COMPLEXUS, and naming the lower part of the muscle COMPLEXUS, though it never had been distinguished from the rest.

The BIVENTER of ALBINUS is the upper layer of the muscle, that part which appears in the fork of the splenii: and if we have hitherto named it complexus, from

from its mixture of tendons and flesh, it was particularly improper to transfer that name to another part of the muscle which is less complicated. This upper layer, the BIVENTER CERVICIS, is attached by a large broad head to the occipital bone; in the centre of this belly there is a confusion of tendon; then there is a middle tendon about the middle of the arch of the neck, and the lower part of the biventer arises from two parts: first, by one slip of flesh from the two uppermost spines of the back; and, secondly, by a larger fleshy portion which comes from the fourth, fifth, sixth, and seventh transverse processes of the back. And it is from the upper and lower fleshy heads, and the confused middle tendon that it is called biventer.

The COMPLEXUS of ALBINUS lies below this one. It arises by three tendinous and fleshy slips, from the three upper transverse processes of the back. Then it has four other slips from four oblique or articulating processes of the neck; which various origins are gathered into one thick irregular fleshy belly, which is implanted into the occiput under the great head of the biventer, and mixed with it. This I have chosen to explain, lest the student should be embarrassed by false names; referring him to the first paragraph for the true and simple description of this muscle.

CXX. TRACHELO-MASTOIDEUS *.—The last muscle is often named COMPLEXUS MAJOR, and this COMPLEXUS MINOR; but a fitter name is the TRACHELO-MASTOIDEUS, from its origin in the neck, and its insertion in the mastoid process.

It has exactly or nearly the same origin, and the same insertion with the splenius; for it arises, not from the spines indeed, but from the transverse processes of the back and neck, and is implanted into the mastoid process.

Its origin is from the three first vertebræ of the back,

* It is the TRACHELO-MASTOIDEUS, the MASTOIDEUS LATERALIS, the CAPITIS PAR-TERTIUS, the COMPLEXUS MINOR; by some it is considered as a part of the COMPLEXUS.

and

and from the five loweſt of the neck, at their tranſverſe proceſſes. Its origins are by diſtinct tendons, and its belly is in ſome degree mixed of tendon and fleſh, whence its name of complexus minor. It is inſerted into the maſtoid proceſs, juſt under the inſertion of the occipital part of the ſplenius; and indeed its long and flat belly lies all along under that muſcle, ſo that the order of diſſection is this: 1. The TRAPEZIUS. 2. The SPLENIUS CAPITIS. 3. The SPLENIUS CERVICIS. 4. The TRACHELO-MASTOIDEUS.

It is needleſs to ſpeak of its uſe, ſince the uſe of all theſe muſcles is to draw the head backwards directly, when both act; obliquely, when one acts alone.

The RECTI MUSCLES are two deep-ſeated muſcles, which go immediately from the vertebræ to the occiput, to be inſerted into its lower ridge. They are called major and minor.

CXXI. The RECTUS MINOR is the ſhorter of the two, ariſing from the firſt vertebra of the neck. Its place of origin is a ſmall tuber which ſtands in the place of the tranſverſe proceſs of the firſt vertebra, and from that point, where it is tendinous, it goes up to the occipital ridge, and is inſerted fleſhy.

CXXII. The RECTUS MAJOR is larger. It ariſes, in like manner, tendinous, from the ſecond vertebra of the neck at its tranſverſe proceſs, and mounting from that, is inſerted fleſhy into the lower ridge of the occiput without the former. Theſe are ſo placed, that the recti minores appear in the interſtice of the recti majores. And though we call them both recti, yet they cannot truly be ſo; for the recti minores muſt be, in ſome degree, oblique, and the recti majores ſtill more ſo: and conſequently, although their chief uſe be conjointly to draw the head directly backwards, yet one acting muſt turn the head to its ſide. And indeed the ſame may be ſaid of all the muſcles of the neck.

The OBLIQUUS SUPERIOR and OBLIQUUS INFERIOR, correſpond very cloſely in all things with the recti; but, in

in their oblique direction the uppermost, as being much shorter, has been named obliquus minor, the lower one obliquus major.

CXXIII. The OBLIQUUS SUPERIOR arises from the transverse process of the atlas, and is inserted into the end of the lower occipital ridge. Its use, notwithstanding its oblique position, is not to turn, but to bend the head backwards, for the occipital condyles standing obliquely, do not permit the rotatory motion of the head on the first vertebra. Its insertion into the occiput is under the splenius and complexus: but one edge of it is above the insertion of the rectus major.

CXXIV. The OBLIQUUS INFERIOR rises from one vertebra and goes to another. It arises from the spine of the second vertebra: it goes to the transverse process of the first, and it meets the superior oblique muscle; and this one obtains great power, by the lateral projection of the atlas giving it a lever power. The first vertebra or atlas rolls on the tooth-like process of the dentatus; and while the great and slow motions of the neck in general are performed by other muscles, there is a presumption that the short and quick turnings of the head are performed by these oblique muscles.

MUSCLES OF THE TRUNK.

The great muscles which move the back and loins are the QUADRATUS LUMBORUM, SACRO LUMBALIS, and LONGISSIMUS DORSI.

The sacro lumbalis and longissimus dorsi run by the side of the spine, and lie immediately under the latissimus dorsi, which is the outer layer; the quadratus lumborum lies again under these, and next to the abdominal cavity. Although the quadratus lumborum lies deep under the longissimus dorsi muscle, I shall describe it first for the sake of a connection which will be presently understood.

CXXV. The QUADRATUS LUMBORUM is a flat squared muscle, named quadratus from its square, or rather oblong form. It arises fleshy from three or four

inches

inches of the back part of the os ilium, and from the ligaments of the pelvis, which tie the back part of the ilium to the ſide of the ſacrum, and to the tranſverſe proceſſes of the loins. As it goes upwards along the ſide of the lumbar vertebræ, it takes hold of the points of the tranſverſe proceſſes of each, by ſmall tendinous ſlips; ſo that we are almoſt at a loſs whether to conſider theſe as new origins or as inſertions: but its chief inſertion is into the lower edge of the laſt rib, and a ſmall production of it ſlips under the arch of the diaphragm, to be implanted into the body or fore part of the laſt vertebra of the back.

The LONGISSIMUS DORSI and SACRO LUMBALIS have their origin in one common and broad tendon coming from the ſacrum, ilium, and loins; the two muſcles lie alongſide of each other; the longiſſimus dorſi is nearer the ſpine, and keeps its tendons cloſer by the ſpine. The ſacro lumbalis is farther from the ſpine, and ſpreads its tendinous feet broader upon the ſides of the thorax: and if one be a little under the other, it is the outer edge of the longiſſimus dorſi, which is a little under the edge of the lumbar muſcle.

The common tendon and muſcle (for there is for ſome way but one muſcle), begins thus: it may be ſaid to have two kinds of adheſion, for, firſt, externally it appears a broad, flat, and ſhining tendon, which ariſes tendinous from all the ſpines of the lumbar vertebræ; from the ſpines of the ſacrum, and from the back part of the os ilium. But the inner ſurface of this broad tendon is ſtrongly fleſhy; for it ariſes fleſhy from the back part of the ilium; from the deep hollow betwixt the ilium and ſacrum; from the ſides of the long ſpines of the lumbar vertebræ; and from their articulating proceſſes, and the roots of their tranſverſe proceſſes. In ſhort, its origin is all tendinous without, and all fleſhy within; and its fleſh ariſes from all that irregular ſurface which is on either ſide of the ſpine, betwixt the os ilium and the vertebræ of the loins; and thus it continues one ſtrong tendinous and fleſhy muſcle, filling up all the hollow of the loins. There is an ap-

 pearance

pearance of ſeparation, ſomething like a ſplit in the tendon, which ſhows in the loins what part of the tendon belongs to each muſcle; but it is only in the back that they are fairly divided.

Juſt oppoſite to the loweſt rib, the longiſſimus dorſi and ſacro lumbalis break off from the common tendon; and the longiſſimus keeps cloſe by the vertebræ, while the ſacro lumbalis is implanted into the ribs.

CXXVI. The LONGISSIMUS DORSI is a muſcle of the ſpine. It is not a flat muſcle, but round, thick, and firm, filling up all the hollow betwixt the ſpine and the angle of the ribs. It is of a long form, as its name implies, terminating towards its top almoſt in a point. It has two diſtinct ſets of feet by which it is inſerted; one ſet of feet more fleſhy, but ſmall and neat, go outwards from the ſide, as it were, of the muſcle to be implanted near the heads of the ribs; the lower ones farther out than the heads of the ribs; the upper ones cloſe to the head, and conſequently cloſer to the ſpine. Theſe heads are nine or ten in number, correſponding with the nine or ten uppermoſt ribs. Another ſet of heads, which are not ſo well ſeen as this ſet, becauſe they lie more under the muſcle, are ſmall, neat, and tendinous; they go in an oppoſite direction, viz. inwards and upwards; keep cloſer by the ſpine, and are inſerted into the tranſverſe proceſſes of the vertebræ of the back. This ſet of heads is thirteen in number, implanted into the tranſverſe proceſſes of all the back, and of one vertebra of the neck.

CXXVII. The SACRO LUMBALIS ſeparates from the longiſſimus dorſi at the laſt rib, and is a flatter and leſs fleſhy muſcle: its twelve tendons are flatter than thoſe of the longiſſimus dorſi, and go out wider from the ſpine. The tendons next to the longiſſimus dorſi, run higheſt up, and are the longeſt; thoſe fartheſt from the ſpine, i. e. fartheſt out upon the cheſt, are the ſhorteſt. It has a flat tendon for each rib, which takes hold upon the lower edge of the rib. But it has another order of ſmall muſcles which mix with it; for as the longiſſimus dorſi has a double row of inſertion, this has another ſet of attach-

attachment, for there arises from the surface of each rib, at least of the six or seven lowest ribs, a small slip of flesh, which runs into the substance of the sacro lumbalis, and mixes with it; and these fleshy slips go by the name of the ADDITAMENTUM AD SACRO-LUMBALEM, or MUSCULI ACCESSORII.

Both these muscle, viz. the longissimus and sacro-lumbalis, terminate in points which reach towards the neck, and under the point of each, there lie the roots of two small muscles, which go up to move the neck. Many have referred these slips going up into the neck, entirely to the muscles I am now describing, calling one an ascending slip of the longissimus dorsi, and the other a slip of the sacro-lumbalis, while others have described them as distinct muscles, having but slight connections with the longissimus and sacro-lumbalis. Their proper names are CERVICALIS DESCENDENS, and TRANSVERSALIS COLLI.

CXXVIII. The CERVICALIS DESCENDENS is connected with the sacro-lumbalis muscle; it cannot be entirely referred to it, for the cervicalis descendens arises as a distinct muscle from the five lower vertebræ of the neck, at their transverse processes, goes downwards very small and slender, to be inserted into the six uppermost ribs, to get at which it slips under the longest tendons of the sacro-lumbalis; but that the cervicalis descendens does not belong to the sacro-lumbalis may be inferred from its having distinct tendons from six ribs, and from six transverse processes of the neck, and from these tendons being in a direction, which does not at all correspond with the heads of the sacro-lumbalis. Indeed the longissimus dorsi has a better claim to this muscle; for a long slip, partly tendinous and partly fleshy, runs upwards from the longest tendon of the longissimus dorsi, to join itself to the cervicalis descendens *.

CXXIX. The

* Hence it is plain that the sacro-lumbalis and longissimus dorsi have nearly an equal claim to this cervicalis descendens. For, first, the longissimus dorsi sends its longest tendon fairly up into the cervicalis

CXXIX. The TRANSVERSALIS COLLI is that which Sabatier refers to the longiſſimus dorſi; but it is a diſtinct muſcle, ariſing partly tendinous, and partly fleſhy, from the five upper tranſverſe proceſſes of the back; lies betwixt the trachelo maſtoideus and the cervicalis deſcendens; goes from the tranſverſe proceſſes of the back to the tranſverſe proceſſes of the neck, and has no more than a confuſed and irregular connection with any other muſcle.

The QUADRATUS LUMBORUM keeps the trunk erect, by the action of both muſcles at once, inclines it to one ſide, or turns it upon its axis, when one only acts; and by its inſertion into the ribs, muſt aſſiſt in high breathing, by pulling down the ribs. The LONGISSIMUS DORSI has no power but over the ſpine, which it bends backwards, acting continually in keeping the trunk erect. This is alſo the chief uſe of the ſacro-lumbalis; but the SACRO LUMBALIS going out further upon the ribs, takes ſuch hold upon them, that beſides its common action of raiſing the trunk, it may, on occaſions, pull them down, aſſiſting the quadratus and the lower ſerrated muſcle. And it will have greater power in turning the trunk of the body upon its axis, than the longiſſimus dorſi, which pulls almoſt directly backwards. The CERVICALIS DESCENDENS co-operates with the trachelo maſtoideus, and others, which turn the head to one ſide; and the cervicalis deſcendens bends the neck to one ſide, both the one and the other being independent muſcles.

Theſe two muſcles bring us to mention that intricate ſet of muſcles which fills up all the hollows and interſtices among the ſpines and irregular proceſſes of the vertebræ, which might be fairly reckoned as one muſcle, ſince they are one in place and in office, but

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vicalis deſcendens, ſo far, that the ſlip is implanted into the tranſverſe proceſſes of the neck. And, ſecondly, the feet of the cervicalis deſcendens begin under the laſt tendons of the ſacro-lumbalis, ſo as to have the appearance of ariſing from its ſupplementary muſcle, the additamentum, and being a part of it; and indeed Sabatier has deſcribed it according to this view.

which

which the anatomiſt may ſeparate into an infinite number, with various and perplexing names; an opportunity which anatomiſts have been careful not to loſe.

The ſurface of the back, from the bulge of the ribs on one ſide, to the bulge of the ribs on the oppoſite ſide of the thorax, is one confuſed ſurface, conſiſting of innumerable hollows, proceſſes, and points of bone; and it is tied from point to point with innumerable ſmall muſcles, or unequal bundles of mixed tendon and fleſh. There are many points, as the ſpinous, tranſverſe, and oblique proceſſes of the vertebræ, and the bulging heads and angles of the ribs; and each proceſs, or at leaſt each ſet of proceſſes, has its diſtinct ſets of muſcles and tendons.

1. There is one long continuity of muſcular and tendinous fibres going from ſpine to ſpine, and lying on the ſide of the ſpinous proceſſes along the whole length of the back and neck. This is divided into the SPINALIS CERVICIS, and the SPINALIS DORSI.

2. There is a ſimilar continuation of fibres, with leſs tendon and more fleſh, belonging one half to the ſpinous, and the other half to the tranſverſe proceſſes, whence it is named SEMI-SPINALIS DORSI.

3. There is a great maſs lying all along the hollow of the back, on each ſide of the ſpinous proceſſes, which paſſing alternately from the tranſverſe proceſs of one vertebra, to the ſpinous proceſs of the next above, is of courſe ſplit into many heads, but yet having ſuch connection as to give it the form and name of a ſingle muſcle, the MULTIFIDUS SPINÆ.

4. and 5. There are yet ſmaller muſcular faſciculi which ſtand perpendicularly betwixt every two tranſverſe, and every two ſpinous proceſſes; thence they are named INTER-TRANSVERSARII and INTER-SPINALES.

CXXX. The SPINALIS CERVICIS is that which is implanted into the ſpines of the cervical vertebræ; but becauſe it does not go from ſpine to ſpine, like the ſpinalis

nalis dorſi, but from tranſverſe proceſſes to ſpines, it has been named by Winſlow, SEMI-SPINALIS, or, TRANSVERSO-SPINALIS COLLI. It ariſes from the tranſverſe proceſſes of the ſix upper vertebræ of the back, and is inſerted into all the ſpinous proceſſes of the vertebræ of the neck, except the firſt and laſt; and it extends the neck, or by its obliquity, may contribute to the turnings of the neck, or to bending it to one ſide *.

CXXXI. The SPINALIS DORSI ariſes from two ſpinous proceſſes of the loins, and from the three lower ſpines of the back, and paſſing two ſpines untouched, it is implanted into all the ſpines of the back, except the uppermoſt. This muſcle is very ſlender and long, and conſiſts fully more of tendon than of fleſh: it has five feet below, riſing from the lower ſpines of the back and loins; and nine feet above, implanted into the upper ſpines of the back. Its action muſt raiſe the ſpine, but perhaps it may be equally uſeful, as a muſcular and tendinous ligament.

CXXXII. The SEMI SPINALIS DORSI ariſes from the tranſverſe proceſſes of the lower vertebræ of the back, all but two; and is implanted into the upper ſpinous proceſſes of the back, and into the firſt ſpine of the neck †.

CXXXIII. The MULTIFIDUS SPINÆ runs from the ſacrum along all the ſpine, to the vertebræ of the neck; and is a comprehenſive and true way of deſcribing many irregular portions of fleſh, which authors have divided into diſtinct muſcles ‡. It is a con-

* The TRANSVERSALIS CERVICIS (vide p. 301.) is that which goes from the tranſverſe proceſſes of the back to the tranſverſe proceſſes of the neck; while this, the SPINALIS CERVICIS, goes from the tranſverſe proceſſes of the back to the ſpines of the neck.

† This is of courſe the TRANSVERSO SPINALIS DORSI of Winſlow.

‡ TRANSVERSO-SPINALIS LUMBORUM, veterib. SACER. SEMI-SPINALIS INTERNUS, ſive TRANSVERSO-SPINALIS DORSI. SEMI-SPINALIS, ſive TRANSVERSO-SPINALIS COLLI, pars interna.—Winſlow. TRANSVERSALIS LUMBORUM, vulgo SACER. TRANSVERSALIS DORSI. TRANSVERSALIS COLLI.

tinued fleſhy indentation, from tranſverſe proceſs to ſpine, through all the vertebræ of the back, neck, and loins.

It begins both tendinous and fleſhy, from the upper convex ſurface of the os ſacrum, which is rough with ſpines, from the adjoining part of the ilium ; and in the loins, it ariſes from oblique proceſſes : in the back, from tranſverſe proceſſes ; and again from oblique proceſſes, among the cervical vertebræ.

Its origin in the loins, is cloſe to the ſpine, being from the oblique proceſſes, and from the root of the tranſverſe proceſſes. In the back it ariſes from the tranſverſe proceſſes, and therefore, ariſes there by more diſtinct heads. In the neck again, it ariſes from the lower oblique proceſſes, more confuſedly.

Its bundles or faſciculi are inſerted into the ſpinous proceſſes, ſometimes into the ſecond, or even into the third or fourth ſpine, above that from which the bundle ariſes ; for the tendons do not ſtop at that ſpinous proceſs which they firſt touch, but go upwards, taking attachments to other two or three, and mixing their tendons with thoſe of the faſciculi, above and below ; and theſe tendons reach from the firſt of the loins to all the vertebræ up to the atlas, which is the only one not included.

The uſe of the multifidus ſpinæ, is to retain the ſpine from being too much bent forward ; for theſe muſcles ſerve (as I have obſerved) the purpoſe of a ligament, and the beſt of all ligaments, having a degree of ſtrength, exactly proportioned to the neceſſity for ſtrength. It alſo moves the ſpine backwards, though perhaps it is leſs uſeful in this, than as a ligament ; for we find it as ſtrong in the vertebræ of the back, which have little motion betwixt the individual bones, and what little there is, muſt conſequently be general. It ſeems rather intended to moderate the lateral motions of the vertebræ than to produce them : when it acts, its chief uſe is either to reſiſt the ſpine being bent forward by a weight, or to erect the ſpine.

CXXXIV.

CXXXIV. The INTER-SPINALES COLLI, DORSI, and LUMRORUM, have varieties, ſo little intereſting, that they need hardly be deſcribed. The INTER-SPINALES COLLI are ſtronger, becauſe the neck has many and quick motions, and the bifurcated ſpines of the neck give broader ſurfaces for theſe muſcles. The INTER-SPINALES DORSI are almoſt entirely wanting, becauſe the ſpines of the back are cloſe upon each other, and the vertebræ are almoſt fixed. The INTER-SPINALES in the LOINS, are rather tendons or ligaments, than proper muſcles.

CXXXV. The INTER-TRANSVERSALES, are again ſtronger and fuller in the neck, becauſe of the lateral motions of the neck being free, and its tranſverſe proceſſes forked. They are in more numerous bundles, where the motion is greateſt, viz. betwixt the atlas and dentatus; and it is there, that Albinus counts his INTER-TRANSVERSALES CERVICIS, PRIORES-LATERALES, &c. The inter-tranſverſarii are wanting in the BACK, giving place to the ligaments, by which they are tied to each other, and to the ribs; but in the LOINS, the inter-tranſverſarii are again ſtrong, for the lateral or twiſting motions of the loins.

The muſcles on the fore part of the head and neck will complete the catalogue of thoſe belonging to the ſpine, and they are the chief antagoniſts to the muſcles which I have been deſcribing.

CXXXVI. The PLATYSMA MYOIDES * is a very thin muſcular expanſion, like the cutaneous muſcle in animals. It is ſpread over the other muſcles, immediately under the ſkin, and covers the whole neck and lower part of the face.

It ariſes from the cellular ſubſtance and aponeuroſis, which cover the pectoral muſcle, the deltoid muſcle, and the clavicle. Its origin is by long ſeparate fleſhy ſlips; it goes like a thin integument over the neck, and is firſt

* The PLATYSMA-MYOIDES is alſo named MUSCULUS CUTANEUS LATISSIMUS COLLI, and QUADRATUS GENÆ.

inſerted about the depreſſor anguli oris, and then going over the maſſeter, is loſt betwixt the muſcles and the integuments of the cheek.

Perhaps it ſerves alſo to pull down the ſkin of the cheek, and the angle of the mouth; but its chief inſertion is into the lower jaw, and its uſe to pull it downwards.

CXXXVII. MASTOIDEUS. — This muſcle ariſes partly from the clavicle, partly from the ſternum. Albinus reckons it two muſcles, the STERNO-MASTOIDEUS, and CLEIDO-MASTOIDEUS; a more common name is the STERNO-CLEIDO-MASTOIDEUS; but here, as in other things, I adhere to what is plaineſt. And the moſt familiar and eaſy name is, MUSCULUS MASTOIDEUS, conſidering the clavicular portion, as an addition only.

Its origin, from the upper part of the ſternum, is pretty round. It ariſes again flat from the fore part of the clavicle; and this ſecond origin is broad and fleſhy, while the firſt one is tendinous and pointed. Theſe two heads form together a very big ſtrong bellied fleſhy muſcle, which is inſerted into the maſtoid proceſs by a broad tendon, which indeed ſurrounds the maſtoid proceſs, and from that, extends ſtill backwards, towards the lambdoidal ſuture. When one of the maſtoid muſcles acts, it turns the head to one ſide; when both act, they pull the head directly forwards.

CXXXVIII. RECTUS INTERNUS CAPITIS MAJOR. — There are three muſcles on each ſide, lying under the œſophagus, trachea, and great veſſels, flat upon the fore part of the vertebræ; and this is the firſt and longeſt.

Although this be called rectus, it is oblique, and running rather on one ſide; for it ariſes from the tranſverſe proceſſes of the five lower vertebræ of the neck, and it is inſerted into the cuneiform proceſſes of the occipital bone, juſt before the foramen magnum.

CXXXIX. RECTUS INTERNUS MINOR. — This is an exceedingly ſmall muſcle; reſembles the obliquus poſterior of the head. It lies immediately under the RECTUS MAJOR: it ariſes from the fore part of the body of the

the firſt vertebra, the atlas, and going (like the other rectus) obliquely inwards, it is inſerted into the occipital bone, near the condyle.

CXL. And the RECTUS CAPITIS LATERALIS, is another ſmall muſcle like the former, which ariſes from the tranſverſe proceſſes of the firſt vertebra, and is inſerted into the ſide of the cuneiform proceſs of the occipital bone. It lies immediately under the exit of the great jugular vein.

CXLI. LONGUS COLLI. This is the chief of thoſe muſcles which lie upon the fore part of the neck; it is very long, ariſing from the flat internal ſurface of the vertebræ of the back, to go up along thoſe of the neck.

Its origin is firſt within the thorax, from the three uppermoſt vertebræ of the back, from the flat part of their bodies, and then from all the tranſverſe proceſſes of the neck, except the three upper ones. It is inſerted tendinous into the fore part of the ſecond vertebra of the neck, where the oppoſite large muſcles meet in one point almoſt *.

All theſe muſcles, which lie thus flat upon the plain ſurface of the vertebræ of the neck, pull the head and neck directly forwards; or when one acts, they are of uſe in pulling it towards one ſide; though I rather ſuppoſe this motion is performed by the external muſcles chiefly.

CXLII. The SCALENUS I conſider as one muſcle; for it is one in origin, inſertion, and office. Its origin is from the whole upper ſurface of the firſt rib, from its cartilage backwards, and alſo from the ſecond rib; and its inſertion is into the tranſverſe proceſſes of the vertebræ of the neck. But by its broad origin, and its very long inſertion, it gives opportunity for dividing it, into ſeveral faſciculi; and accordingly it has been ſo divided; but theſe diviſions are entirely modern, artificial, and unnatural. The ancients conſidered it as

* The longus colli muſcle is in part covered by the rectus major.

one

one triangular muſcle: Winſlow divided it into two, the primus and ſecundus; Cowper into three; Douglas into four; and Albinus divides it into five muſcles. The antients called it ſcalenus, from its reſemblance to the ſcalen triangle; and the true anatomy is, to conſider it as one great triangular muſcle, flat, and ſtretching from the ribs to the neck, cloſing the thorax above, and giving paſſage to the nerves and veſſels of the arm.

If it were to be deſcribed in diſtinct portions, it would be in three parts. The anterior portion ariſes from the tranſverſe proceſſes of the ſix lower vertebræ of the neck, and is inſerted into the flat part of the firſt rib hard by its cartilage. The middle portion from the four lower vertebræ, goes to the outer edge of the rib, and extends along all its length. The poſterior portion is the thinneſt and longeſt, for it ariſes from the tranſverſe proceſſes of the ſecond, third, and fourth vertetebræ. It is inſerted into the upper edge of the rib, about an inch or more from its articulation with the ſpine.

The firſt head is tendinous and fleſhy at its inſertion into the rib; but the ſecond and third heads are tendinous, both in their origins and inſertions.

The nerves paſs in the interſtice betwixt the firſt and ſecond portions.

The office of the ſcalenus muſcle is to pull the neck to one ſide, or to bend the head and neck forward, when both act; and when the neck is fixed backwards, they may perhaps raiſe the ribs; for aſthmatics are obſerved to throw the head backwards, in order to raiſe the cheſt with greater power.

CHAP.

CHAP. VI.

OF THE MUSCLES OF THE ABDOMEN, AND OF THE DIAPHRAGM.

THE abdominal mufcles cover in the belly, contain the bowels, and take a firm hold upon the pelvis and the trunk. The diaphragm, again, is a moving partition betwixt the thorax and the abdomen, and the diaphragm preffing down the bowels upon the abdominal mufcles enlarges the thorax, and the abdominal mufcles re-acting pufh the bowels back upon the diaphragm, and comprefs the thorax. Thus, the alternate yielding and re-action of the abdominal mufcles and diaphragm perform breathing, agitates the bowels, promotes the circulation, expels the fœces and urine, affifts the womb in the delivery of the child. And, with all thefe important ufes, the abdominal mufcles bend and turn the trunk, and fix it for the ftronger actions of the limbs. They fteady the body in lifting weights, in bearing loads, in all our more violent exertions they often give way under this double office of breathing, and of ftraining, along with the reft of the body; and the bowels coming out through their natural openings, or by burfting through the interftices of their fibres, form herniæ of various kinds. Whence the anatomy of thefe mufcles is moft interefting to the furgeon.

The mufcles of the abdomen are five on either fide. 1. The outer oblique mufcle, to which the names of DESCENDENS, DECLIVIS, and MAJOR, are added, becaufe it is the outermoft of all the abdominal mufcles, becaufe it is the largeft, covering all the fide of the abdomen with its flefhy belly, and all the forepart of the abdomen with its broad expanded tendon; and it is called declivis, or defcendens, becaufe its flefhy belly begins above, upon the borders of the thorax; and becaufe both its mufcular and tendinous fibres which lie parallel

to each other, run obliquely from above downwards and inwards.

2. The OBLIQUUS INTERNUS is named from its being within the firſt, and has the names of ASCENDENS, vel MINOR ſuperadded, becauſe its fleſhy belly is ſmaller than that of the firſt, ariſes below chiefly in the haunch-bone, and all its fibres go from below upwards.

3. The TRANSVERSALIS lies under all the others, and next to the cavity of the abdomen, and has but one name, which alſo is derived from the direction of its fibres running acroſs, or round the abdomen.

4. The RECTUS, ſo named, becauſe of its running on the fore part of the abdomen, in one ſtraight line from the os pubis to the ſternum.

5. The PYRAMIDAL muſcle is the only one named from its ſhape. It is a ſmall, neat, conical muſcle, which ariſes from the os pubis, by a broad baſis, and has its apex turned upwards; but it is not always found, for it is only as a ſupplement to the recti muſcles, and as a part of them, whence it has been named MUSCULUS SUCCENTURIATUS, or ſupplementary muſcle.

CXLIII. The EXTERNAL OBLIQUE muſcle ariſes from the ribs, and, like all the others which ariſe from ribs, is a ſerrated muſcle. It comes from the eight lower ribs, by diſtinct fleſhy tongues, one from each rib. Theſe ſerræ are mixed with the indentations of the ſerratus major anticus muſcle, which goes off in an oppoſite direction, and with the origin of the pectoralis major. The origin of the muſcle lying broad upon the border of the cheſt, it is its thickeſt and moſt fleſhy part, whence its fibres go down all in one direction, parallel with each other, but oblique with reſpect to the abdomen. Its fleſhy belly ceaſes about the middle of the ſide. Its flat ſheet of tendon goes over the fore part of the belly, till it meets its fellow exactly in the middle, ſo that one half, or the back part of the abdomen is covered by its fleſhy belly, and the fore part by its tendinous expanſion.

The muſcle meets its fellow in the middle of the belly; and this meeting forms (along with the other tendons)

tendons) a white line from the pubes to the ſternum, which is named LINEA ALBA. It alſo, before it reaches the middle, adheres to the flat tendon of the tranſverſalis. This meeting is about four inches on either ſide of the linea alba, and is a little inclined to the circular, whence it is named linea ſemilunaris. And, finally, this muſcle is implanted into the ſpine of the ilium, fleſhy about the middle of the ilium, tendinous at the forepart, or ſpinous proceſs of the ilium, and ſtill tendinous into the whole length of that ligament, which extends from the ſpine of the ilium to the creſt of the pubes.

This is the whole of its inſertion, viz. all the length of the linea alba, from the pubes to the ſternum, the fore part of the ſpine of the ilium, and the ligament of Paupart, which, though it is commonly thought to be but the tendon of the external oblique ſtretching from point to point, is, in truth, a diſtinct ligament, independent of the tendon, and ſtronger than it.

CXLIV. OBLIQUUS INTERNUS ABDOMINIS. — The chief part of this muſcle ariſes thick and fleſhy from all the circle of the ſpine of the ilium, with its fibres directed upwards. But, to be accurate, we muſt deſcribe it as ariſing from the whole length of the ſpine of the ilium, from the joining of the ilium and ſacrum, from the ſpines of the ſacrum itſelf, and from the three lower ſpinous proceſſes of the loins *; and, laſtly, it ariſes from the ligament of the thigh, at its end next to the ilium; but ſtill the chief belly is at the iliac ſpine. From that it ſpreads upwards in a radiated form; the central fibres only are direct, going acroſs the abdomen to the linea alba; the higher fibres aſcend and go towards the ſternum, and the lower ones go obliquely downwards to the pubes. Its flat tendon is like that of the external oblique, and it is inſerted into the cartilages of all the falſe ribs, into the ſternum, and into the linea alba, through its whole length.

* This origin from the ſpinous proceſſes of the loins, is a thin tendon, common with the ſerratus and latiſſimus dorſi muſcles.

CXLV. The

CXLV. The TRANSVERSALIS ABDOMINIS forms the internal layer, it runs directly acroſs the belly. It ariſes fleſhy from the inner ſurface of the ſix lower ribs, where its digitations mix with thoſe by which the diaphragm ariſes; tendinous from the tranſverſe proceſſes of the four lower lumbar vertebræ; from the whole ſpine of the os ilium, and from a part of the femoral ligament. Upon the whole, its origin is like that of the inner oblique muſcle; its fibres go acroſs the abdomen, and its tendon is inſerted into the whole length of the linea alba.

The ſucceſſion in which theſe three muſcles ariſe from the cheſt, is this: the external oblique muſcle lies broad upon the outſide of the cheſt, and ſo its tongues mix with the tongues of the ſerratus anticus major. The internal oblique muſcle again riſes lower down the thorax, from its edge, from the cartilages of the ribs. The tranſverſe muſcle ariſes within the thorax, from the internal ſurface of the ribs, oppoſite to where the tongues of the external oblique lie; and the diaphragm ariſing from the ſame ribs, mixes its indigitations with the tranſverſalis, ſo that Caſpar Bartholin, obſerving this indigitation to be very curious in the larger animals, believed the diaphragm and tranſverſe muſcles to be but one great trigaſtric, or three-bellied muſcle, ſurrounding all the abdomen. But the tranſverſalis, with the other abdominal muſcles, are the antagoniſts of the diaphragm.

CXLVI. The RECTI muſcles cover the abdomen on its fore part, in a line from the pubes to the ſternum, and they belong ſo equally to the ſternum and to the os pubis, that it is indifferent which we call their origin, and which their inſertion. The origin (as I ſhould call it) of each rectus muſcle is in the ſternum, is broad and fleſhy, lies upon the outſide of the ſternum, covering part of the ſternum, and all the xiphoid cartilage, and touching and mixing its fibres with the great pectoral muſcle. It is about four inches broad all down the abdomen, and terminates at the ſide of the ſymphyſis pubis, with a flat and pointed tendon about an inch in length, and about an inch broad. This muſcle is croſſed at intervals by

four tendinous interſections, which divide it into five diſtinct bellies. Commonly there are three bellies above the umbilicus, and two below; but the recti muſcles are the leaſt regular of all the muſcles of the abdomen. Veſalius, Albinus, and Sabatier, were thought to have found the recti abdominis extending up to the throat. But it is now found that Veſalius had only repreſented the muſcles of a monkey, or of a dog, which are very long, upon the thorax of a human ſubject. Sabatier, upon reviſing his notes, retracts what he had ſaid: and Albinus alſo is ſuppoſed to have ſeen only a production of the maſtoid muſcle, extending down the breaſt; for irregularities of this kind have been found.

CXLVII. The PYRAMIDAL muſcles are as a ſupplement to the recti. There is a ſmall neat pyramidal muſcle on each ſide, or rather a triangular muſcle, fleſhy through its whole extent and length, with its baſe turned towards the pubes, and its apex towards the umbilicus; ſo that its origin is in the creſt of the pubes, and its pointed inſertion in the linea alba: and though the recti muſcles have been ſuppoſed by Maſſa to relate to the penis, or by Fallopius to belong to the urinary bladder, their true uſe is only to aſſiſt the rectus to draw down the ſternum, and tighten the linea alba, and ſo to give greater power to the oblique and tranſverſe muſcles. The pyramidalis is ſo irregular a muſcle, that ſometimes two are found on one ſide, and none at all on the other. Sometimes two on each other; ſometimes there is but one, and very often they are wanting, the belly of the rectus coming quite down to the pubes.

1. The LINEA ALBA is the common meeting of all the thin flat tendons, and therefore we call it their inſertion, being the common point towards which they all act; it is white, by the gathering of all the colourleſs tendons.

2. The LINEA SEMILUNARIS is a line of the ſame white appearance, of a circular form, and produced by the meeting of all the tendons, on the edge of the rectus muſcle, to form a ſheath for it.

3. The SHEATH for the RECTUS MUSCLE does not admit

admit of ſo brief a definition as this: it has been commonly ſuppoſed to be formed in a very curious manner, chiefly by the broad tendon of the obliquus internus, which being the central muſcle, betwixt the two other layers, is ſuppoſed to have its tendon ſplit into two thin ſheets; that the outermoſt ſheet adheres to the outer oblique muſcle, forming the outer part of the ſheath, while its inner ſheet adheres to the tendon of the tranſverſe muſcle, forming the inner part of the ſheath; but this is too intricate, and can hardly be proved by diſſection. Cowper expreſſes his doubts about this doctrine of the tendon of the inner oblique muſcle being ſplit into two layers; and I think the trueſt deſcription is this, that all the tendons meet, and adhere in the ſemilunar line; that they immediately part to form this ſheath; that the flat tendons of both the oblique muſcles go upon the outer ſurface of the rectus, to form that ſide of the ſheath; that the tendon of the tranſverſe muſcle only lies under the rectus, forming the lower part of the ſheath, and that it is unaſſiſted by any lamella of the inner oblique muſcle; that the ſheath is complete at the fore part, or over the muſcle; but that under the muſcle the ſheath ſtops about five or ſix inches above the pubes, and that there, the recti muſcles (or in their place the pyramidal muſcles), lie bare upon the bladder, and other abdominal viſcera, lined only by the thin peritonæum *. And that this back layer of the ſheath is thinner and more delicate, and but little attached to the back part of the rectus muſcle, which is eaſily raiſed in diſſection, while the fore part of the ſheath adheres firmly to the fore part of the muſcle, forming thoſe croſs bands, or tendinous interſections which divide the rectus into bellies, and the ſheath where it lies over the muſcle cannot be diſſected without a degree of violence, either to the ſheath, or to theſe tendinous interſections.

* Cowper had never obſerved this but once, that the lower part of the rectus was not lined by the tendon of the tranſverſalis. He concluded, that in this inſtance, it was a ſporting of nature; "ſo much a luſus naturæ, that accidents like this might be the "cauſe of certain ruptures."

4. The UMBILICUS is that opening in the centre of the abdomen, in the middle of the linea alba, through which the nutritious veſſels of the fœtus paſs. The veſſels have degenerated into ligaments in the adult, and the umbilicus is cloſed in the form of a ring; but ſometimes it is forced by violent action, and the viſcera come out by it, forming umbilical hernia.

5. The RING of the ABDOMINAL MUSCLES is that opening near the lower part of the abdomen, juſt over the pubes, through which the ſpermatic cord paſſes in men, and the round ligament of the womb in women.

Cowper (p. 5.) ſays, that the ſpermatic cord paſſes through ſeparate rings, in each of the three abdominal muſcles; and, like older authors, he makes nature exceedingly wiſe, in placing the rings not oppoſite to each other, but one high, and another lower, and a third lower ſtill, ſo as to prevent the bowels falling out. But the truth is, that neither the internal oblique nor the tranſverſe muſcles, have any ſhare at all in the ring, which belongs entirely to the external oblique muſcle, and is formed in this way: all the tendinous fibres of the external oblique, are, like the muſcle itſelf, oblique, running from above downwards; and the tendinous faſciculi, are in ſome places wider, a little disjoined from each other, and reſembling ſtripes, croſſed by ſmall threads of tendon, as if the long fibres were in danger of parting from each other, ſo as to leave a gap, and were held together by theſe croſs threads; and it is in fact a wider and perfect ſeparation of two fibres that forms the ring, and a ſtronger interlacement of croſs fibres, that ſecures it from ſplitting farther up. But the chief ſecurity of the ring, is by the form of the opening; for it is not a ring as we call it, but a mere ſplit in the tendon, which begins about an inch and a half above the pubes, is oblique, and looking towards the pubes, like the fibres which form it, and conſiſts of two legs, or pillars of the ring, as they are called; for the upper ſlip which forms the upper part of the opening, goes directly towards the creſt, or higheſt point of the pubes; the lower pillar, or the ſlip which forms the lower line of the ſlit, turns in behind,

gets under the upper one, and is implanted into the pubes, within and behind the upper pillar: this lower ſlip forms at once the lower pillar of the ring and the edge of the femoral ligament.

Now this croſſing of the pillars of the ring ſecures it; for the more the muſcle pulls, in preſſing upon the abdominal viſcera, the tighter is the ſlit drawn; and the obliquity of the opening, gives the direction to herniæ of the groin, which always point towards the pubes, ſo as to fall into the ſcrotum in men, or into the labia pudendi in women, keeping cloſe by the groin.

The ſpermatic cord, formed of the veſſels belonging to the teſticle, paſſes through this ring of the external oblique muſcle; but as the internal and oblique tranſverſe muſcles form no ſhare in the ring, the cord paſſes by their lower edge, but not through them. At the place where the cord paſſes obliquely under the edge of the internal oblique muſcle, it ſends a bundle of fleſhy fibres down along the cord, which go all along the cord, gradually extend towards the teſticle, expanding and growing thin upon the upper end of the teſticle, and gradually diſappearing on the tunica vaginalis.

CXLVIII. The CREMASTER MUSCLE of the TESTICLE, which is a thin ſlip of fibres from the internal oblique muſcle of the abdomen, which is deſigned for ſuſpending the teſticle, and for drawing it up, is very thick and ſtrong in the lower animals, as in bulls, dogs, &c.; is eaſily found in man, but not always, being ſometimes thin and pale, and hardly to be known from the coats upon which it lies. It appears to grow more fleſhy in old age, and to be thickened in enlargements of the teſticle, the better to ſupport the weight.

6. The LIGAMENT of the THIGH * is a diſtinct ligament, and not merely the tendon of the external oblique,

* This ligament of the thigh is named alſo the INGUINAL LIGAMENT; the CRURAL ARCH; the LIGAMENT of PAUPART; the LIGAMENT of FALLOPIUS, &c.

rounded and turned in. It arifes from the fpinous procefs of the ilium, and is inferted into the creft of the pubis. It receives the external oblique mufcle, for the tendon is implanted into it. Part of the flefh of the internal oblique mufcles arife from the outer end of the ligament. It forms an arch over the pfoas and iliacus internus mufcles, where the great artery of the thigh, and its anterior nerve pafs out, and it is tied down at both fides of the paffage for the veffels by the fafcia of the thigh. The great vein, and the lymphatics of the limb, return under it to get into the abdomen; the lymphatic glands of the groin lie here; the whole interftice is furrounded and filled up by cellular fubftance and fat, but it is not firm; the playing of the mufcles and the fat, and inguinal glands, keep it open and lax; and the bowels are apt to fall down here, efpecially in women, where the point of the ilium is high, and the arch wide. So little are femoral herniæ, or the form of this opening underftood, that no particular cufhion is adapted to this part; for it is fupported by the common bandage for the hernia of the groin: and, a few years ago, hernia of the groin was not even known by anatomifts of the higheft name. For Cowper fays, (explaining Paupart's ligament), " It is not impoffible but that ruptures " may fometimes happen in this part; and I am apt " to imagine this to be the cafe when a rupture is very " large, and not to be retained by a trufs."

It often happens, that in vomiting, in violent coughing, in ftraining at ftool, or in lifting heavy weights, the natural openings are forced, and the bowels defcend. The UMBILICUS is very feldom forced by fudden exertion, for it is a very firm ring; but it is flowly dilated in pregnancy, and hernia of the navel is infinitely more frequent with women than with men. — The opening of the RING is often kept dilated by the bowels following the tefticle when it defcends; forming the congenital hernia; moft frequently of all, the ring is forced in ftrong young men by hard and continued labour, or by fudden ftraining; but women are fafer from this kind of hernia, becaufe

becaufe the round ligament of the womb is fmaller than the fpermatic cord, and the ring in them is very clofe. — ABDOMINAL HERNIÆ are thofe which come not through any natural opening, but through the interftices of the mufcles, or their tendons; fometimes hernia follows a wound of the abdomen; for a wound of the abdominal mufcles may not heal fo neatly as not to leave fome fmall interftice, through which the bowels protrude. Thus any point may be forced by violence; any of the openings, or all of them may be relaxed by weaknefs, as in dropfical or other lingering difeafes: for it is from this caufe that herniæ are more frequent in childhood and in old age, by the laxity which is natural to childhood, or by the weaknefs natural to the decline of life. Often there feems to be a hereditary difpofition to herniæ in certain houfes, the form of the openings of the abdomen being wider in a whole family, juft as the features of the face are peculiar. And I have feen a child with all thefe openings fo particularly wide, that upon the flighteft coughing or crying, herniæ came down at every poffible point, at the navel, the fcrotum, the thigh, and in the fides of the abdomen, all at once; or, as one tumor was reduced, another arofe.

The effects of the abdominal mufcles in moving the trunk cannot be miftaken. The RECTI pull the ribs downwards in breathing, flattening the belly, and bending the body forwards. The two OBLIQUE MUSCLES of of one fide acting, turn the trunk upon its axis; but the oblique mufcles of the oppofite fide acting, co-operate with the rectus in flattening the belly, and bending the body; and the TRANSVERSE MUSCLES tighten the linea alba, fo as to give effect to all the others; and particularly they brace the fheath of the recti mufcles, fo as to give them their true effect.

CXLIX. The DIAPHRAGMA is a Greek word, tranflated inter-feptum, the tranfverfe partition betwixt the abdomen and the thorax, the midriff; but it is not merely a tranfverfe partition, it is a vaulted divifion betwixt the thorax and abdomen; and not only is the

 middle

middle raiſed into a vaulted form, but its obliquity is ſuch, that though its fore part be as high as the ſternum, its lower and back part ariſes near the pelvis from the loweſt vertebra of the loins.

It is a circular muſcle, which is fleſhy towards its borders, and tendinous in the centre; which is convex towards the thorax, and concave towards the abdomen; becoming plain, or almoſt ſo, when it preſſes againſt the abdominal muſcles in drawing the breath; and returning to its convex form, when the abdominal muſcles re-act in puſhing it back into the thorax.

The diaphragm ariſes, by one broad fleſhy attachment, from all the borders of the cheſt, forming the upper or greater muſcle of the diaphragm; and it ariſes below, by many ſmall tendinous feet, from the fore part of the loins, which meeting, form what is called the leſſer muſcle of the diaphragm. 1ſt, The GREAT or UPPER muſcle ariſes, firſt, from under the xiphoid cartilage, and from the lower ſurface of the ſternum. 2dly, From all the falſe ribs; from the cartilage of the ſeventh, eighth, and ninth ribs; and from the bony parts of the tenth and eleventh ribs, and from the tip of the twelfth rib. All theſe origins are, of courſe, fleſhy digitations or tongues which intermix with thoſe of the tranſverſe muſcle of the abdomen. 3dly, From the tip of the twelfth rib to the lumbar vertebræ, there is a ligament extended, which, going like an arch over the pſoas and quadratus lumborum muſcles, is named LIGAMENTUM ARCUATUM; and from this another part ſtill of the great muſcle of the diaphragm ariſes. Thus, the the upper muſcle of the diaphragm has four chief origins, viz. from under the ſternum and xiphoid cartilage; from all the falſe ribs; from the ligamentum arcuatum; and, in ſhort, from all the borders of the cheſt, from the xiphoid cartilage quite round to the vertebræ of the loins.

2. The LESSER MUSCLE of the DIAPHRAGM, which ariſes from the ſpine, begins by four ſmall ſlender tendinous feet on each ſide. The firſt of theſe, the longeſt one, ariſes from the ſecond vertebra above the pelvis: it goes

goes from the flat fore part of its body, and adheres to the fore part of all the lumbar vertebræ as it mounts upwards. The ſecond riſes from the third vertebra, but farther out towards the ſide of the vertebra. The third ariſes from the ſide of the fourth vertebra. And the fourth tendon of the diaphragm ariſes from the the tranſverſe proceſs of the ſame fourth vertebra of the loins. But indeed we ought, in place of this minute demonſtration, to ſay, that it ariſes from the four uppermoſt lumbar vertebræ by four tendinous feet, flat and gliſtening, and adhering cloſely to the ſhining ligament with which the bodies of the vertebræ are ſtrengthened; that theſe tendons ſoon join to form two ſtrong round fleſhy legs, which are called the crura diaphragmatis; of which crura, the left is the ſmaller one: and theſe crura having opened to admit the aorta betwixt them, and then joining, mixing, and croſſing their fibres, form a fleſhy belly, the leſſer muſcle of the diaphragm.

3. The TENDON in the centre of the diaphragm is determined in its ſhape by the extent of theſe fleſhy bellies; for the great muſcle above almoſt ſurrounds the central tendon. The ſmaller muſcle below meeting it, the two diviſions give it a pointed form behind; the tendon has the figure of a trefoil leaf, or of the heart painted upon playing cards. The middle line of this tendinous centre is fixed by the membrane which divides the thorax into two; the two ſides go upwards into the two ſides of the cheſt, each with a form like the bottom of an inverted baſin: their convexity reaching within the thorax, quite up to the level of the fourth true rib: the proper centre of the diaphragm is fixed by this connection with the mediaſtinum, that its motion might not diſorder the action of the heart, which reſts upon this point, and whoſe pericardium is fixed to the tendon: but the convexity of either ſide deſcends and aſcends alternately as the diaphragm contracts, or is relaxed; ſo that it is chiefly theſe convexities on either ſide, which are moved in breathing.

Thus, is the diaphragm compoſed of one great and circular muſcle before; of one ſmaller circular muſcle behind;

behind; and of the triangular tendon, as the centre betwixt them: and, both in its fleshy and tendinous parts, it is perforated by several vessels passing reciprocally betwixt the thorax and the abdomen.

First, the AORTA, or great artery of the trunk, passes betwixt the crura or legs of the diaphragm, which, like an arch, strides over it to defend it from pressure.

Secondly, The ŒSOPHAGUS passes through the diaphragm, a little above this, and to the left side: its passage is through the lower fleshy belly, and through the most fleshy part of the diaphragm: and the muscular fibres of the crura diaphragmatis first cross under the hole for the œsophagus; then surround it; then cross again above the hole; so that they form the figure of 8: and the œsophagus is so apparently compressed by these surrounding fibres, that some anatomists have reckoned this a sort of sphincter for the upper orifice of the stomach.

Thirdly, The great VENA CAVA goes up from the abdomen to the heart, through the right side of the diaphragm; and this hole being of a triangular form, being in the firm tendon, there is no danger of strangulation or of the blood being impeded in the vein.

The tendon is composed of fibres which come from the various fasciculi of this muscle, meet and cross each other with a confused interlacement, which Albinus has been at much pains to trace, but which Haller reports much more sensibly: "Intricationes variæ et vix dicendæ;" irregular and confused, crossing chiefly at the openings, and especially at the vena cava, the triangular form of which seems to be guarded in a most particular way.

The lower surface of the diaphragm is lined with the peritonæum, or membrane of the abdomen; and the upper surface is covered with the pleura, or membrane of the chest. The hole for the vena cava is so large that the peritonæum and pleura meet, and touch each other through this opening, all round the vein.

The chief use of the diaphragm is in breathing, and in this office it is so perfect, that though there be a

complete

complete anchylosis of the ribs (as has often happened), the person lives and breathes, and never feels the loss. The diaphragm is, in its natural state, convex towards the thorax; when it acts, it becomes plain, the thorax is enlarged, and, by the mere weight of the air, the lungs are unfolded, and follow the diaphragm. No vacuum is ever found betwixt the diaphragm and the lungs; but the lungs follow the ribs and diaphragm as closely as if they adhered to them: and indeed when they do adhere, it is not known by any distress. So we draw in the breath, and when the abdominal muscles re-act, the diaphragm yields, goes back into the thorax, and grows convex again, by which we blow out the breath; and while the diaphragm is acting, the abdominal muscles are relaxed, yield, and are pushed out, and leave the ribs free, to be raised by their levator muscles. And again, when the abdominal muscles re-act, the diaphragm in its turn yields so, that they at once force up the diaphragm, and pull down the borders of the thorax, assisting the serrated muscles which depress the ribs.

There is also in every great function, such a wonderful combination of actions conspiring to one end, as cannot be even enumerated here. But the alternate action and re-action of the abdominal muscles draws in and expels the breath, promotes the circulation, and gently agitates the bowels, while their more violent actions discharge the fæces and urine, and assist the womb; and vomiting, yawning, coughing, laughing, crying, hiccup, and the rest, are its stronger and irregular actions. The diaphragm might well be named by Haller, "Nobilissimus post cor musculus." And Buffon, who affected the character of anatomist with but little knowledge of the human body, might mistake its central tendon for a nervous centre, the place of all motions, and almost the seat of the soul. For the antients confounded the names and ideas of tendon and nerve. And, in sickness and oppression, lowness and sighing, in weeping or laughing, in joy, or in fear, all our feelings seem to concentrate in this part.

CHAP.

CHAP. VII.

THE MUSCLES OF THE PARTS OF GENERATION, AND OF THE ANUS, AND PERINÆUM.

THE muſcles of the parts of generation follow the diviſion of the abdominal muſcles more naturally than any other.

The ERECTOR PENIS is a ſmall and ſlender muſcle, which goes over the crus penis, and braces it back to the pubes. The erectores are ſuppoſed (by preſſing the the penis againſt the pubis) to compreſs the great vein, and ſo cauſe erection. The ACCELARATOR URINÆ is a muſcle which ſurrounds all the bulb of the urethra, and acts by a ſort of ſubſultus in diſcharging the laſt drops of the urine, and in throwing out the ſemen. And the TRANSVERSALIS perinæi, which goes acroſs the perinæum, belongs rather to the anus than to the penis.

The SPHINCTER ANI is a circular bundle of fibres, which ſurrounds the orifice of the anus, and contracts it; and the levator ani is a flat thin muſcle, which lines the pelvis, ſurrounds the rectum like a funnel, and being fixed round the margin of the anus, raiſes it up; and the COCCYGÆUS is but a part of it. The DETRUSOR URINÆ is the muſcular coat of the bladder, and the SPHINCTER VESICÆ is not eaſily diſtinguiſhed from the detruſor urinæ, being but the fibres of it, only thicker and ſtronger at the lower and narrower part of the bladder.

The penis is compoſed of two crura, or cavernous bodies, which ariſe from the branch of each os iſchium, which ſoon meet to form the body of the penis; and of the corpus cavernoſum urethræ, which ſurrounds the urethra, is attached to no bone, but begins juſt before the circle of the anus, by a bulging, which is called the bulb of the urethra; and the erector penis lies along the crura, to draw them back to the pubes; and the acce-

lerator

lerator ſurrounds all the bulb, and acts in expelling the ſemen, or the laſt drops of urine.

CL. The ERECTOR PENIS is a delicate and ſlender muſcle, about two inches in length. It lies along the face of the crus penis of each ſide. And when the crura penis are inflated, the erectors are ſeen of their proper length and form. The erector of each ſide riſes by a ſlender tendon from the tuberoſity of the os iſchium. It goes fleſhy, thin, and flat, over the crus penis, like a thin covering. It ends in a delicate and flat tendon, upon the crus penis, about two inches up; and the tendon is ſo thin and delicate, that it is hardly to be diſtinguiſhed from the membrane of the cavernous body.

The erectors lying thus on the ſides of the penis, have been called COLATERALES PENIS, or ISCHIO-CAVERNOSI, from their origin in the iſchium, and their inſertion into the cavernous bodies.

CLI. The TRANSVERSALIS PERINÆI is often named tranſverſalis penis; but its origin being in the tuberoſity of the os iſchium, by a delicate tendon, and its inſertion into the very backmoſt point of the bulb of the urethra, where it touches the anus, its courſe is directly acroſs the perinæum, and its relation to the perinæum and anus is very direct and evident, while its relation to the penis is rather doubtful. Often there is a ſecond muſcle of the ſame origin and inſertion, running like this, acroſs the perinæum, named TRANSVERSALIS PERINÆI ALTER.

This tranſverſe muſcle may, by bracing up the bulb to the arch of the pubis, have ſome effect in ſtopping the vein on the back of the penis, and ſo producing erection; but its chief uſe muſt be in preventing the anus from being too much protruded in diſcharging the fæces, and in retracting it when it is already protruded.

CLII. The ACCELERATOR muſcle is not a ſingle muſcle, as it is often deſcribed. It is manifeſtly a pair of muſcles ſurrounding the whole of the bulb of the urethra. For there is along the lower face of the

bulb

bulb, a white and tendinous line, correſponding with the outward line or ſeam of the perinæum. This line diſtinguiſhes the bellies of the two muſcles: the fibres of each ſide ſurround their proper half of the bulb with circular fibres, winding obliquely round the bulb; and each muſcle ends in its ſeparate tendon, which is delicate and ſmall, and which, leaving the bulb of the urethra, turns off obliquely to the ſide, ſo that the tendon of each ſide goes out flat and thin upon the crus penis of its own ſide, a little higher than the inſertion of the erector penis; and thus it embraces the bulb itſelf, with its two crura. We know and feel its convulſive, involuntary action in throwing out the ſeed; and we are conſcious that we uſe it as a voluntary muſcle in emptying the urethra of the laſt drops of urine.

CLIII. The SPHINCTER ANI muſcle is a broad circular band of fibres, which ſurrounds the anus. It ariſes from the point of the os coccygis behind. It ſends a neat ſmall ſlip forwards, by which it is attached to the back part of the accelerator muſcle. It is of a regular oval form, and is, for a very obvious reaſon, ſtronger in man than in animals. Some chooſe to enumerate two ſphincter muſcles, of which this is the external, or cutaneous; and what they deſcribe as the internal one, is merely the circular fibres, or muſcular coat of the inteſtine, ſtrengthened a little towards the anus, but not a diſtinct muſcle. Its effect is to ſhut the anus.

CLIV. The LEVATOR ANI muſcle is deſcribed as a pair of muſcles, one from each ſide: but it is properly one broad and thin muſcle, which ariſes from the internal ſurface of all the fore part of the pelvis, and, from its breadth, it has been named MUSCULUS ANI LATUS. It continues its origin from the internal ſurface of the pubes, all the way round to the ſacrum. It grows gradually ſmaller, as it goes downward to ſurround the anus. So it is inſerted into the circle of the anus, into the point of the os coccygis, and is mixed with the ſphincter ani muſcle. The whole pelvis is lined with it like a funnel, or inverted cone, the wider part repreſenting its origin from the pelvis, the narrower part its

 inſertion

insertion into the anus. The whole bladder is surrounded, and covered by this muscle; the urethra passes through a split in its fibres, and no operation of lithotomy can reach the bladder from below, without cutting through this muscle. It raises the anus, and at the same time dilates it, opening the anus for the passage of the fæces, and supporting it, so as to prevent its being protruded. Thus, it is not for shutting the anus, as some have supposed, but is the direct antagonist of the sphincter ani muscle. By enclosing the bladder, the levator ani acts upon it also; for the neck of the bladder passing through a slit in its fibres, while the levator ani is acting, this slit is drawn, as it were, round the neck of the bladder, and so the urine is for the time prevented from flowing. It is as a sphincter to the bladder, which prevents our passing the urine and fæces at the same moment. By surrounding the lower part of the bladder, and enclosing the prostate gland, and the vesiculæ seminales, which lie upon the back of the bladder, this muscle affects these parts also, and is perhaps the only muscle which may be supposed to empty the vesiculæ, or to compress the gland, pulling upwards at the same time, so as to press the back of the penis against the pubes, to maintain the erection, and to assist the accelerator muscles. By enclosing the bladder, vesiculæ, prostate and anus, this muscle produces that sympathy among the parts, which is often very distressing, as in gonorrhœa, the stone in the bladder, constipation, piles, and other diseases of these parts; for piles, constipation, or any cause which may excite the action of the levator muscles, will cause erections, a desire to pass the urine, and an obstruction in the discharge of it.

CLV. The MUSCULUS COCCYGÆUS is a thin, flat muscle, which arises by a narrow point, from the inside of the pelvis, at the spine of the os ischium; is implanted, expanded and fleshy, into the whole length of the os coccygis; can be useful only, by pulling up the point of the os coccygis, which is just equivalent to raising the circle of the anus; so that from every circumstance of its form

form and ufe, it might be fairly enough defcribed, as being merely the back part of the levator ani mufcle.

The perinæum, where the bulb begins, is the point into which all the mufcles are united; for the accelerator mufcle, and the fphincter ani mufcle, touch at the beginning or point of the bulb; and a fmall pointed flip of the fphincter ani, going upon the bulb, connects them firmly together. The tranfverfales perinæi come acrofs the perinæum from either fide; and the levator ani mufcle, comes down to meet the fphincter, fo that the fphincter ani, the levator ani, the tranfverfalis perinæi, and the accelerator urinæ mufcles, all meet in one point, viz. the back of the bulb. They fecure the perinæum, and fupport the heavy vifcera of the abdomen; if they be unfkilfully cut in performing lithotomy, it will be difficult to extract the ftone. In that operation, the incifion paffes by the fide of the anus, and on the infide of the tuber ifchii; and our knife accordingly cuts clean acrofs the tranfverfe mufcles, which ftand as a bar acrofs the perinæum; it paffes by the fide of the erector mufcle, need not touch it, or touches it flightly, and by a fort of chance: it muft not touch the accelerator mufcle; for whoever fays he cuts the accelerator, cuts too low, and performs his operation ill. After the firft incifion we get deep into the pelvis, and cut the levator ani. The furgeon does not obferve thefe mufcles, on account of any danger which may attend wounds of them, but takes them as marks for the true place of his incifion; and a good operator will be careful to have them fairly cut, that they may be no hindrance to the extraction of the ftone *.

* The detrufor urinæ, is but the mufcular coat of the bladder; the fphincter vificæ, or mufcle of the proftates, is but a denfer fafciculus of this common coat of the bladder. I fhould no more think of defcribing them here, than of defcribing the coats of the inteftines or ftomach. Thefe mufcles of internal parts, with the mufcles of the internal ear, &c., I referve for thofe books which defcribe the organs and vifcera.

CHAP.

CHAP. VIII.

MUSCLES OF THE THIGH, LEG, AND FOOT.

MUSCLES MOVING THE THIGH-BONE.

THE mufcles belonging to the thigh-bone, arife all from the pelvis or trunk. The PSOAS MAGNUS and ILIACUS INTERNUS, come from within the pelvis, at its fore part, and paffing under the femoral ligament, go down to be implanted into the trochanter minor; and by this obliquity of their infertion, they turn the toes outwards, and bend the thigh. Other mufcles come from the lower and fore part of the pelvis, as the PECTINALIS, TRICEPS, and OBTURATOR EXTERNUS, which arife from the arch of the os pubis, and go down to be implanted into the linea afpera, and leffer trochanter; and, they pulling the thigh towards the body, are called the ADDUCTORS. Others arife from the facrum, and back part of the pelvis, as the GLUTÆI, which, coming directly forwards to be implanted into the greater trochanter, pull back the thigh; and a fourth fet coming alfo from the internal furface of the pelvis, viz. The OBTURATOR INTERNUS, and the PYRAMIDALIS, come out through the back opening, turn round the pelvis, as round a pulley, and roll the thigh, and draw it back. This completes the catalogue of thofe mufcles which move the thigh.

1. The PSOAS MAGNUS, ILIACUS INTERNUS, PECTINEUS, TRICEPS, OBTURATOR EXTERNUS, which, coming from before, are inferted into the leffer trochanter, and bend the thigh.

2. The GLUTÆI, GEMINI, PYRIFORMIS, OBTURATOR INTERNUS, and QUADRATUS, which come from behind, are implanted into the great trochanter, and extend the thigh; and it hardly need be remembered, that as, when the arms being fixed, their mufcles raife the weight

of the body, as in climbing, or in turning over a bar, by graſping with the hands; ſo the muſcles of the thigh, move that thigh only which is looſe, and free from the weight of the body, while the muſcles of the other thigh, which is fixed by the weight of the body, move not the thigh, but the trunk upon the thigh; ſo that our walking is performed not ſo much by the muſcles of the thigh moving the limb, as by their moving the pelvis, i. e. rolling the trunk upon the limb.

MUSCLES MOVING THE THIGH.

1. THE THIGH IS MOVED BACKWARDS AND OUTWARDS,

By the glutæus maximus,	which is implanted into the	linea aſpera,
——— medius,		trochanter major,
——— minimus,		top of trochanter.

2. THE THIGH IS MOVED BACKWARDS, AND ROLLED UPON ITS AXIS,

By the pyriformis,	which is implanted into the	root of the trochanter,
gemini,		——— ———
obturator externus,		——— ———
——— internus,		——— ———
quadratus,		betwixt the trochanters.

3. THE THIGH IS MOVED FORWARDS AND INWARDS,

By the pſoas magnus,	which are inſerted into the	trochanter minor,
iliacus internus,		——— ———
pectinalis,		linea aſpera.
triceps,		——— ———

Fascialis. I begin with this muſcle, as it is neceſſary in the diſſection. The thigh is encloſed in a very ſtrong ſheath, which, like that of the arm, ſends down among the muſcles ſtrong tendinous ſepta or partitions; and the muſcles are encloſed in theſe ſepta, and the great muſcles of the leg are ſupported by it, in their ſtrong and continual actions. The tendinous faſcia of the thigh ariſes chiefly from the ſpine of the ilium, partly (over the groin) from the external oblique muſcle of the abdomen. Every faſcia has ſomething added by each muſcle, and takes

takes a new increafe, and adhefion at each bone which it paffes. It is always ftrengthened by adhefions to joints, and comes down from them thicker upon the mufcles below; and fo this fafcia of the thigh, which arifes chiefly from the fpine of the ilium, defcends, covering all the mufcles of the thigh : it fends partitions down to the linea afpera, and trochanters; it has a new adhefion, and a new fource of tendinous fibres at the knee; it adheres moft remarkably at the inner fide of the tibia, and then defcends to the calf; it covers all the leg, and is again reinforced at the ancle : and this I believe to be a jufter hiftory than the common idea of making it an expanfion of the fmall tendon of the fmall mufcle, which I am now to defcribe; for the fafcia is too effential to the ftrength of the leg, and would be found there, though this mufcle were away, as is the cafe with the palmar expanfion.

This fafcia rightly confifts of two plates; one is that which comes down from the creft of the ilium, and from the mufcles of the belly; the other, that which arifes purely from the tendon of the mufculus fafcialis, and which is at the fame time, connected with the capfular ligament of the femur, and with the trochanter; and fo the mufcle lies betwixt the two plates of the fafcia; and as the fafcia, at this part, takes at leaft a reinforcement from the capfular ligament, and from about the trochanter major, the fafcialis mufcle may be faid to be inferted into the trochanter.

So this great tendinous fafcia has thefe connections: the creft of the ilium; the ligament of Paupart, at the rim of the belly; the creft and arch of the os pubis; the tuber ifchii, and fo back along the coccyx, to the ridge and proceffes of the facrum; the ligament of the joint, the great trochanter; and the linea afpera, all the way down to the knee, where its laft adhefion is very ftrong, and from whence it comes off again, much ftrengthened.

It is thicker on the outer fide and back part, and very thin on the inner fide of the thigh; and it dives

with perpendicular divifions among the mufcles of the thigh.

CLVI. The FASCIALIS MUSCLE. The mufcle is named tenfor vaginæ femoris. It arifes from the upper fpinous procefs of the ilium, i. e. from the fore part, or very point of its fpine, by a tendon of about an inch in length. It is very fmall at its origin, and at its termination. It is thick and flefhy in the middle, fwelling out; it extends downwards, and obliquely backwards, almoft to the middle of the thigh, and there it terminates obliquely, betwixt the two lamellæ of the membrane to which it belongs.

Its ufe is chiefly as an abductor, and to make the fafcia tenfe, to prepare the mufcles for ftrong action; and perhaps, by its adhefions about the trochanter, it may have fome little effect in rolling the thigh, fo as to turn the toes inwards, and oppofe the Gemini.

CLVII. PSOAS MAGNUS. — This and the following mufcle come from within the body, to move the thigh forwards. This is a very long and flefhy mufcle, of confiderable ftrength, of conftant ufe, perpetually employed in moving the thigh forward, or in fupporting the pelvis upon the thigh-bone, fo as to preferve the equilibrium of the body.

It is named from PSOA, LUMBUS; is a large round mufcle, very ftrong, of great length, filling up all the fpace upon either fide of the fpine, and bounding the pelvis at its fide. It comes from under the ligamentum arcuatum of the diaphragm; for it arifes firft by its uppermoft head from the laft vertebra of the back, then fucceffively from each of the vertebræ of the loins. It fticks clofe to the lumbar vertebræ; for it arifes not only from the tranfverfe proceffes, but from the fides of the bodies. Thefe heads do not appear, for they are covered by the body of the mufcle, which goes down thick and round, till it reaches the facro iliac fymphyfis, and then being united to the internal iliac mufcle, they defcend through Paupart's ligament.

CLVIII. The PSOAS PARVUS does not, like this, belong

belong to the thigh, but is a muſcle of the loins, which ariſes along with this one from the laſt vertebra of the back, and the firſt of the loins. It is a ſmall and delicate muſcle, ends in a ſlender tendon, which goes down by the inner ſide of the great pſoas, but does not go out of the pelvis along with it: it ſtops ſhort, and is implanted into the brim of the pelvis, into the os ilium, near the place of the acetabulum: it bends the ſpine upon the pelvis. This muſcle is more regular in the monkey: in the dog it is ſeldom wanting. It is ſaid to be more frequently found in women than in men; in both, it often is not to be found: but ſometimes, in ſtrong and big men, three pſoas muſcles have been found.

CLIX. The ILIACUS INTERNUS is a thick, very fleſhy, and fan-like muſcle, which occupies the whole concavity of the os ilium.

Its origin is from the internal lip of the criſta ilii: it adheres to all the concave ſurface of that bone, down to the brim of the pelvis; to the fore part of the bone under the ſpinous proceſs; and to a part alſo of the capſular ligament of the joint: all its radiated fibres are gathered together into a tendon at the ligament of Paupart. This tendon is longer on the lower than on the upper ſurface: for below, it ſlides on the pubis as upon a pulley, and continues tendinous that it may bear the friction; but above it is unconnected, or it is connected only by looſe cellular ſubſtance; and there it is quite fleſhy. Juſt under the ligament, the two tendons are joined, whence they bend obliquely round, to be implanted into the leſſer trochanter.

The pſoas magnus and iliacus internus are two very powerful muſcles. Their chief uſe is to bend the thigh, and more peculiarly of the lumbar one to ſupport the body. The great blood veſſels come down along with theſe two muſcles: the muſcles and veſſels are both ſurrounded with looſe cellular ſubſtance; matter often forming behind the abdomen, round the pſoas muſcle, is named the pſoas abſceſs, and penetrating under Pau-

part's ligament, burſts in the thigh at laſt, and is commonly fatal.

CLX. The PECTINEUS or PECTINALIS, ſo named from its ariſing at the pecten or os pubis; is a broad flat ſquare muſcle: it lies along-ſide of the laſt deſcribed muſcles, and is inſerted with their common tendon. It ariſes flat and fleſhy from that line of the os pubis which forms the brim of the pelvis, and is implanted into the linea aſpera by a tendon flat and long, pretty nearly of the ſame extent and ſhape with its origin.

This muſcle lies immediately under the ſkin and faſcia lata; and by its bending round under the thigh-bone, it has three actions; to cloſe the knees together; to pull the thigh forward; to perform rotation, turning out the toe; and, in certain poſitions of the limb, it will pull the thigh back, aſſiſting the extenſor muſcles.

CLXI. The TRICEPS FEMORIS is a broad flat muſcle, with three heads, ariſing from the os pubis, and inſerted into the whole length of the linea aſpera down to the condyle, and ſerving for preſſing the knees together, or bringing the thigh forwards.

The triceps conſiſts of three heads, which lie in different layers, one above the other; and have ſo little connection among themſelves, that they have been more commonly, and I think properly, deſcribed as three muſcles. Theſe three parts of the muſcle are indeed for one common uſe: but they are of very different forms; for they do not even lie on the ſame plane: one is long, another ſhorter by one half, a third longer than both the other two; ſo that they have been commonly deſcribed under the names of ADDUCTOR PRIMUS or LONGUS; ADDUCTOR SECUNDUS or BREVIS; ADDUCTOR TERTIUS or MAGNUS.

1. The ADDUCTOR LONGUS is the uppermoſt layer; its border (for it, like the pectinalis, is a flat muſcle) ranges with the border of the pectinalis. It ariſes from the upper and fore part of the pubis by a ſhort roundiſh tendon, very ſtrong: it ſwells into a thick fleſhy belly, not

not round, but flattened ; the belly grows flatter as it goes down towards the thigh-bone ; it ends in a flat and ſhort tendon, which is inſerted into the linea aſpera in all its middle part, viz. about four inches. Thus, the muſcle is of a triangular form, with its baſe in the linea aſpera, and its apex on the os pubis. Its head or origin lies betwixt the pectinalis and the gracilis : its upper edge ranges with the pectinalis ; its lower edge lies upon the triceps magnus. It is called longus, becauſe it is longer than the next muſcle.

2. The ADDUCTOR BREVIS lies under the adductor longus, and is of another layer of muſcles ; for as the firſt layer conſiſts of the pectinalis, triceps longus, and gracilis, this layer conſiſts of the obturator externus, triceps brevis, and triceps magnus. The triceps brevis is exceedingly like the former, in riſing near the ſymphyſis pubis, by a thick and flattened tendon, ſwelling like it into a ſtrong fleſhy belly ; like it, it grows flat, and is inſerted by a ſhort flat tendon into the inner trochanter and linea aſpera. But it differs in theſe points : that it is leſs oblique, for this muſcle being ſhorter, goes more directly acroſs betwixt the pelvis and the thigh : that it is placed higher than the laſt, ſo that whereas the layers are inſerted into the middle of the thigh-bone, this one is inſerted into the leſſer trochanter, and only the upper part of the linea aſpera ; and the triceps longus is a ſuperficial muſcle, while this is hidden under it, and behind it. The longus takes its riſe from the very creſt of the os pubis ; this takes its origin from the forepart of the os pubis, from the limb juſt under the creſt, ſo as to be immediately under the head of the longus.

3. The ADDUCTOR MAGNUS, the third head of the triceps, is a very long and flat muſcle, lying behind the other heads. It ariſes by a ſhort tendon, juſt under the tendon of the adductor brevis ; it continues to have a fleſhy origin all down to the ramus, and to the tuber iſchii, (i. e.) from the flat edge of the thyroid hole. From this broad origin, it goes to be implanted into the thigh-bone the whole length of the linea aſpera, its

fibres having various degrees of obliquity, according to their infertion, for the uppermoft fafciculi go almoft directly acrofs, to be inferted flat into the upper part of the linea afpera; the fucceeding fafciculi go more and more obliquely as they defcend, the lower part of the mufcle following that rough line which leads to the condyle, and the laft fibres of all are implanted, by a tendon of confiderable length, into the condyle itfelf. This adductor magnus makes as it were a flat partition betwixt the fore and the back parts of the thigh; and it is about three inches above the condyle that the great artery paffes betwixt this tendon and the bone perforating the triceps, to get from the fore to the back part of the thigh, and down into the ham.

The ufe of all thefe mufcles is entirely the fame, making allowance for their various degrees of oblique infertion; and they muft be very powerful, by the great diftance of their origins from the centre of that bone which they move, fo that while other mufcles pull in a direction very oblique, thefe three heads of the triceps muft pull more at right angles, and therefore at a more favourable direction.

CLXII. The OBTURATOR EXTERNUS is named after the obturator ligament, from which it arifes. The ligament and the mufcles fhutting up the foramen thyroideum are named OBTURATORS, and it is fometimes named ROTATOR FEMORIS EXTRORSUM, from its turning the thigh outwards. It arifes from the ramus of the ifchium and os pubis, where they form the margins of the thyroid hole; and from the outer furface of the ligament, which it occupies entirely, leaving only room for the obturator veffels and nerves. It is a fhort mufcle; its origin is broad, and its infertion narrow, fo that it is of a conical form; for the flefh of its mufcles is gathered very foon into a round fhort tendon, which twifts under the thigh-bone betwixt it and the pelvis; fo that it is in a manner rolled round the thigh-bone, being inferted into the root of the great trochanter. It pulls the thigh forwards, but is more peculiarly a ro-

tator

tator of the thigh. This muſcle is of the ſecond layer, and the ſucceſſion of all the muſcles is this; the upper layer conſiſts of the pſoas and iliacus, where they come out from the abdomen, of the pectinalis, and of the long head of the triceps; the ſecond layer conſiſts of the ſhort head of the triceps; and the third layer conſiſts of the obturator externus at the upper part, and the triceps magnus, or third head of the triceps, all down to the condyle.

GLUTÆI.—There are three glutæi muſcles, each under the other, and each ſmaller than the muſcle which covers it. The FIRST, ariſing from the back part of the ilium, the back of the ſacrum, and the ſacro-ſciatic ligament, forms the whole hip, and deſcends ſo low as to be inſerted into one-third of the length of the linea aſpera, and into the root of the great trochanter.

The SECOND ariſes from all that portion of the ilium, which is before this one, and from the back of the bone, and goes down to be inſerted into the very top of the great trochanter.

The THIRD ariſes from the back of the bone below the laſt; and it is inſerted into the root betwixt the apex of the great trochanter and the neck of the bone.

CLXIII. The GLUTÆUS MAXIMUS ariſes from the back of the ilium one half its length; from the joining of the ilium and ſacrum; from all the ſpines and irregularities of the ſacrum; and from the ſacro-ſciatic ligament. Its thick fleſhy faſciculæ come in a winding and oblique direction down to the thigh-bone; and, being gathered into a flat and pretty broad tendon, it is inſerted into the root of the trochanter major, and down three inches of the linea aſpera. This is one of the largeſt and moſt fleſhy muſcles of the body; covers all the other muſcles of the hip; forms the contour of the hip; pulls the thigh backwards, or the body forwards upon the thigh, when the thigh is fixed: and being a wide-ſpreading muſcle, which, in a manner, ſurrounds

ſurrounds its joint, its different portions act with different effects; not only according to their natural direction, but according to the accidental poſitions of the pelvis with regard to the thigh-bone.

CXLIV. The GLUTÆUS MEDIUS or MINOR, is ſmaller than the former, but like it. It ariſes from all the outſide of the ilium not occupied by the glutæus major. It, like the other, is a fan-formed muſcle; for its fibres converge from its broad origin in all the back of the ilium, to form a ſhort flat tendon which is inſerted into the back, or into the very top of the great trochanter. It lies in part under the glutæus maximus; but its chief part lies before the glutæus maximus; and as certain portions of the muſcle are before the thigh-bone, there are poſitions of the pelvis and thigh-bone in which it will pull the thigh forwards, although its proper office is to aſſiſt the glutæus magnus in pulling the thigh backwards, and moving it outwards from the body.

CLXV. The GLUTÆUS MINIMUS is a ſmall radiated muſcle, which lies deep, and quite under the former. It has, compared with the former, a very narrow origin; for it ariſes chiefly from the loweſt part of the back of the ilium, viz. that part which forms the ſocket for the thigh-bone, and a little higher up, and from the border of the ſciatic notch. It forms a ſhort, flat, and ſtrong tendon, which is fixed under the root of the trochanter major, betwixt the trochanter and the neck of the bone: ſo that theſe muſcles are inſerted in this ſucceſſion; firſt, the great glutæus, below the root of the trochanter, and into the linea aſpera; the middle glutæus into the back and top of the trochanter; and the ſmalleſt of the glutæi is implanted into the roughneſs under the root of the trochanter.

GEMINI. — The gemini are two muſcles, or rather one biceps muſcle; but the heads are ſo diſtinct, that they are reckoned two, and ſo much alike, that they are named GEMINI.

CLXVI. The uppermoſt, the larger, and ſtronger muſcle ariſes from the ſpinous proceſs of the os iſchium.

CLXVII. The

CLXVII. The ſecond or ſmaller head ariſes in like manner from the tuber iſchii, upon its ball or outer end. They are fleſhy in their whole length. They meet, and unite their tendons at the great trochanter. They are inſerted firmly along with the following tendon, at the root of that proceſs.

CLXVIII. The PYRIFORMIS, or pyramidalis, comes from the hollow of the ſacrum, runs in the ſame line with the leſſer glutæus, and is inſerted with the two laſt-named muſcles in the root of the great trochanter.

Its origin is from the hollow of the ſacrum, riſing from the vertebræ of that bone, by three or four ſmall fleſhy digits; and from the ſacro-ſciatic notch, it runs betwixt the glutæus minor and the gemini, and its round tendon is inſerted betwixt them, ſomewhat connected with each.

The pyriformis, gemini, obturator internus, and quadratus, form what ſome anatomiſts have called MUSCULI QUADRIGEMINI; and they are ſo much alike in inſertion and uſe, that it would be waſte of time to repeat what has been ſaid of the gemini and obturator.

This muſcle, the pyriformis, like the others, rolls the thigh outwards. Its name is from its ſhape.

CLXIX. The OBTURATOR INTERNUS, once named MARSUPIALIS, or BURSALIS, ariſes from all the internal ſurface of the obturator ligament, and from all the edges of the thyroid hole, from the ilium, iſchium, and pubis. Its origin is therefore circular and fleſhy. It runs along the inſide of the os iſchium, turns round that bone betwixt the ſpinous proceſs and the tuber. The hollow there is guarded with cartilage, and this tendon runs in the hollow, like a pulley round a rope; paſſing this, it runs betwixt the two legs of the gemini, and its tendon is united to theirs; and the three appearing almoſt like one tendon, are inſerted together into the root of the trochanter major. Theſe, then, might with ſome propriety be named one muſcle; all the three, viz. the two gemini muſcles, and the obturator muſcle paſſing between them, were once accounted as one muſcle,

muſcle, and then it ſeemed to be a muſcle with two bellies, and an intermediate tendon; and this intermediate tendon, with two fleſhy ends, give it the appearance of a purſe, thence named MARSUPIALIS, or BURSALIS.

CLXX. The QUADRATUS FEMORIS, is a thin flat muſcle, paſſing in a tranſverſe direction betwixt the tuber iſchii and the thigh-bone.

It ariſes from the lower and flattened ſurface of the TUBER ISCHII by a ſhort tendinous beginning. It goes a little obliquely upwards and outwards, and is inſerted into the back of the great trochanter, in that roughneſs which is found juſt were the trochanter is joined to the bone, and goes obliquely betwixt the trochanter major and the trochanter minor.

It rolls the thigh-bone, ſo as to turn the toe outwards, and pulls it almoſt directly backwards.

The MOTIONS of the THIGH muſt be performed by many very ſtrong muſcles, as it moves under the weight of the whole body; and it ſeems to be curiouſly contrived, that the muſcles fit for moving the thigh forward, ſhould, in certain poſitions of the thigh, move it backwards; alſo giving an increaſe of ſtrength to that motion of the thigh in which moſt ſtrength is required.

There are but two, or chiefly two points for inſertion; the trochanter major and trochanter minor. Theſe two points are ſo oblique, that no one muſcle, nor ſet of muſcles, performs any direct motions; for they all twiſt round the bone's axis, to get at their inſertion. The glutæi, the pyriformis, the gemini, the quadratus, the obturator internus, and obturator externus, all bend round the axis of the thigh-bone, to reach the TROCHANTER MAJOR. Theſe now may be called the abductors of the thigh, to pull it outwards; but we ſhould conclude from this direction, that they could not pull the thigh backwards, for the thigh-bone would turn on its axis and elude their action.

The pſoas magnus, the iliacus internus, the pectinalis

nalis, and the triceps, do in the ſame manner, go round the inner ſide of the bone: the two firſt to be implanted into the trochanter minor, the two latter into the linea aſpera, juſt below it. Theſe are juſtly named adductors of the thigh: their chief uſe is to draw the thighs together, and this is their combined effect: when the adductors act by themſelves, they pull the thigh forwards, moving the leg, rolling the thigh-bone, and turning the toe out in a graceful ſtep; which is moſt peculiarly the effect of the pectinalis and triceps. But when we are to finiſh the motion, by pulling forward the body, which is the ſame with pulling back the thigh, it is not merely the antagoniſts of theſe muſcles, as the glutæi, the gemini, &c. which muſt act. Were the glutæi to act alone, they would rather turn the thigh upon its axis outwards than pull it back; but the triceps, &c. act again in conjunction with the glutæi, &c. and by the action of the triceps, the inner trochanter is fixed: the further rolling of the thigh is prevented; the full effect is given to the glutæi muſcles. When the glutæi act, they pull the thigh directly backwards, aſſiſted by the triceps, pectinalis, and others: for now the thigh-bone is ſo far advanced before the body, that thoſe muſcles, as the triceps which were benders of the thigh in its firſt poſition, are extenſors when it is advanced a ſtep before the body; or, perhaps, it will be more explicit to ſay, that when the thigh is moved one ſtep before the body, the iliacus internus, pſoas magnus, and triceps muſcles, agree with the glutæi muſcles in bringing the trunk forwards to follow the limb, and then in fixing and ſtiffening the trunk upon that limb, till the other thigh is advanced again a ſtep before the body.

The MUSCLES of the LEG, are the moſt ſimple of all; for the knee is a mere hinge, at leaſt, it is ſo in all our ordinary motions, ſo that there is no action to be performed, but thoſe of mere flexion and extenſion, and there are only two claſſes of muſcles to be deſcribed, the extenſors and the flexors of the leg.

1. The EXTENSORS of the LEG. The only muſcles which

which extend the leg, are thoſe four, which may be very fairly reckoned a quadriceps extenſor cruris. Indeed the French anatomiſts arrange them ſo. Sabatier calls them the triceps femoris. Theſe muſcles, which all converge to the patella, and are inſerted in it, are, RECTUS FEMORIS, — CRURÆUS, or FEMORÆUS, — VASTUS EXTERNUS, — VASTUS INTERNUS.

And theſe are all implanted by one tendon; becauſe the joint being a hinge, bending only in one direction, its muſcles could have given but one motion, however oblique their origin and courſe had been.

2. The FLEXORS of the LEG are one on the outſide, and four on the inſide of the leg; the tendons of the outſide being implanted into the upper knob of the fibula, and thoſe in the inſide, into the rough head of the tibia, forming the hamſtrings, and extending their tendons or aponeurotic expanſions, downwards upon the leg.

INSIDE FLEXORS.

Sartorius,	Gracilis,
Semitendinoſus,	Semimembranoſus.

OUTSIDE FLEXOR.

Biceps.

EXTENSORS OF THE LEG.

CLXXI. The RECTUS FEMORIS, ſometimes RECTUS CRURIS, is ſo named from its direction; it ariſes by two heads. The firſt or greater head ariſes from the lower ſpinous proceſs of the ilium by a ſhort round tendon; its ſecond head is in a different, and ſomewhat of a curved direction; for it comes from the edge of the acetabulum, and from the capſular ligament. Theſe join together, and form a flat tendon of four inches in length, which becomes gradually fleſhy and larger down to its middle, and then again contracts towards the patella. There is a middle tendinous line, running the whole length of the muſcle, eſpecially conſpicuous

on

on its back part, and towards that central line, all the muſcular fibres converge.

The rectus is united at the ſides to the vaſti, at the back part of the cruræus; and its tendon, along with that of the cruræus, goes to be directly implanted into the rotula or patella.

The rectus cruris is the firſt of thoſe muſcles which Sabatier calls the TRICEPS FEMORIS; they may be more properly named the QUADRICEPS CRURIS.

This large maſs of muſcle or fleſh enwraps the whole of the thigh-bone behind as well as before; for, firſt, the CRURÆUS ariſes fleſhy from all the fore part of the bone. The VASTUS EXTERNUS from the great trochanter, and all the back part and outer ſide of the bone; and the VASTUS INTERNUS ariſes, in like manner, from the leſſer trochanter, and all the inner ſide of the bone, from the trochanter major all round to the origin of the cruræus.

CLXXII. The CRURÆUS ariſes from the fore part of the TROCHANTER MINOR, and it continues its origin from the fore part of the femur, the whole way down to within two inches, or little more, of the patella. About three inches from its origin it is joined by the VASTUS EXTERNUS, which unites with it at the outer edge and fore-part; and the VASTUS INTERNUS comes into it about five inches below its origin, and it joins it at the inner edge and fore part. At its lower part it is joined to the tendon of the rectus, to form but one large tendon, which is inſerted into the rotula.

Under the cruræus are ſometimes found two little muſcles, or rather two little ſlips of this muſcle, which are quite diſtinct. They ariſe on the fore part of the thigh-bone, two or three inches above the capſule of the joint; and they are inſerted into the capſule on each ſide of the patella, evidently for the purpoſe of pulling it up, to prevent its being catched; and when theſe two (SUBCRURÆI) are not found as diſtinct muſcles, ſome fibres of the cruræus ſupply their place.

CLXXIII. The VASTUS EXTERNUS is the largeſt of theſe three muſcles.

Its

Its origin is, by a pretty thick and ſtrong tendon, from the lower and fore part of the trochanter major; and it continues its origin from the root of the trochanter all down the linea aſpera, to that rough line which goes to the inner tuberoſity of the thigh-bone.

It touches the end of the cruræus about four inches below its origin, and continues attached to it the whole way down; and then it forms a flat tendon which connects itſelf with the tendon of the RECTUS FEMORIS, and then embraces, in a ſemi-circular manner, the outſide of the patella. And ſeveral of the fibres of this aponeuroſis not only croſs over the rotula, but go down over its oppoſite ſide to glide along the head of the tibia, and to be inſerted into the inner ſide of the knee.

CLXXIV. The VASTUS INTERNUS is neither ſo large nor ſo fleſhy as the VASTUS EXTERNUS; but it is exceedingly like it in all other reſpects.

It ariſes from the fore part of the trochanter minor, juſt under the inſertion of the pſoas magnus; and it continues its origin from the linea aſpera the whole way down to the inner condyle, exactly oppoſite to the origin of the vaſtus externus; they leave juſt a channel betwixt them. The vaſtus internus, very ſoon after its origin, joins itſelf to the cruræus, or middle portion, and accompanies it in all its length; and, at the diſtance of two inches from the rotula, it unites itſelf with the tendon of the cruræus at its internal edge; and this tendon completes that junction which unites the four muſcles into a quadriceps cruris. This vaſtus internus deſcends much lower, in a fleſhy form, than the external vaſtus does, and forms that fleſhy cuſhion which covers the inner ſide of the knee-joint. Its tendon embraces the rotula, ſomewhat in the ſame circular form with the vaſtus externus; and, like the externus, it ſends ſome fibres acroſs the knee-pan, to be inſerted in the outer part of the head of the tibia.

The RECTUS, and the VASTUS EXTERNUS, INTERNUS, and CRURÆUS, form one large maſs of fleſh, which

which embraces and encloſes all the thigh-bone ; and they are ſo connected, that the cruræus cannot be ſeparated, and cannot be neatly diſtinguiſhed.

The uſe of theſe four muſcles is evident ; to extend the leg, and to bend the thigh on the trunk, or reciprocally to bend the trunk on the thigh. This, or theſe two motions alternately, is the common uſe of theſe muſcles, as in walking ; and they are moſt peculiarly uſeful in running and leaping.

After deſcribing a large maſs, conjoined in one tendon, and concurring in one ſimple action, it is ſuperfluous to ſay that its power muſt be great. This power muſt be ſtill further encreaſed by the rotula, which removes the force from the centre, and gives the advantage of a pulley, which it really and truly is : without this pulley, theſe muſcles could be of no uſe in certain ſituations ; for inſtance, in the recumbent poſture ; for then the extending muſcles, being in the ſame line with their bones, could have no further power ; but the rectus, by the pulley of the rotula, and by its attachment to the baſin, raiſes the trunk, or at leaſt helps the pſoas, the iliacus, and the muſcles of the belly.

The rotula is again attached to the tibia by a ſtrong ligament, to ſuſtain the pulling of theſe great muſcles *.

FLEXORS OF THE LEG.

CLXXV. The SARTORIUS OR TAYLOR'S MUSCLE, is ſo named from its bending the knees, and drawing the

* Theſe muſcles are in continual action; for their office is to reſiſt the bending of the knee, which would happen by this incumbent weight of the body; ſo that the continual ſupport of the body depends wholly on theſe muſcles ; and they are the great agents in running, leaping, walking, &c. Since by extending the knee they raiſe the weight of the pelvis and trunk, and of all the body, they muſt be very powerful ; and accordingly, when they are weighed againſt their antagoniſt muſcles, we find them greatly to exceed, for the QUADRICEPS, i. e. the rectus, cruræus, and vaſti, will weigh four pounds, while the BICEPS, &c. their antagoniſts, weigh but two pounds. This experiment, was often repeated by the great Cowper, for Mr. Brown, who was delivering lectures on muſcular motion.

 legs

legs acroſs. It is the longeſt muſcle, and a very beautiful one; extends obliquely acroſs the whole length of the thigh, croſſing it like a fillet or garter, about two inches in breadth.

It ariſes from the upper ſpinous proceſs of the os ilium, by a tendon about half an inch in length; its thin flat belly extends obliquely acroſs the thigh, like a ſtrap, and is inſerted into the ſame oblique form into the inner tubercle of the head of the tibia; its aponeuroſis ſpreads widely, going over the whole joint of the knee, a thin ſheet of tendon.

From the oblique poſition of the muſcle, it might in action change its place; but it is ſo far embraced by the faſcia lata, and is tied by ſuch adheſions, as to form ſomething like a peculiar ſheath of itſelf.

It turns the thigh like the quadratus gemini, and obturator muſcles. It alſo bends the leg upon the knee; and when the leg does not yield, it bends the thigh upon the pubes; or where the thigh is alſo fixed, it bends the body forwards; but in performing that action, whence it has its name, it does all theſe: for firſt the leg and thigh are rolled, then the thigh is raiſed, then the leg is bent to draw it acroſs. Though a ſmall muſcle, yet it is of great power from its origin, and in ſome degree, its inſertion alſo, being much removed from the centre of motion.

CLXXVI. The GRACILIS, ſometimes called RECTUS INTERNUS FEMORIS *, is a ſmall, flat, thin muſcle, in its general ſhape ſomewhat like the ſartorius.

It ariſes by a flat tendon of two inches in length from the os pubes, and near the ſymphyſis; and it paſſes immediately under the integuments down to the knee; it paſſes by the inner condyle of the knee, in the form of a ſhort round tendon, and as it bends behind the head of the tibia, it is bound down by a bundle of tendinous fibres, which, croſſing it, go to the back part of the leg. After paſſing the head of the tibia, it turns

* GRACILIS, is from its ſmallneſs; RECTUS INTERNUS, is from its ſtraight direction.

obliquely

obliquely forwards and downwards; it here runs behind the tendon of the ſartorius, and before that of the ſemitendinoſus. It is inſerted with the ſartorius into the ſide of the tuberoſity, at the top of the tibia.

This muſcle runs alſo in a line ſo wide from the centre of motion, that its power is very great. It ſerves chiefly as flexor of the leg: when the leg is fixed, it muſt by its origin from the pubes, be a flexor of the thigh, and an adductor in nearly the ſame direction with the pectineus and triceps; and it is worth obſerving, that while the knee is ſtraight, the ſartorius and the gracilis cannot bend the knee; they, on the contrary, keep it ſteady and firm; but when the knee is bent, they come into action; for in proportion as the muſcles which have made the flexion are contracted, they are leſs able to contract farther, and therefore it is deſirable, that more muſcles ſhould come into play.

CLXXVII. The SEMITENDINOSUS is ſo named, from its lower half being compoſed of a ſmall round tendon; and as tendon was once miſnamed nerve, this is the SEMINERVOSUS of Winſlow, Douglas, and others.

Its origin is from the tuberoſity of the iſchium (along with the ſemimembranoſus, and touching the biceps), by a ſhort thick tendon. It alſo ariſes by many oblique faſciculi of fibres, from the poſterior portion of its oppoſite muſcle the biceps cruris. This croſs connection betwixt the two muſcles continues for three inches down from the tuber iſchii; it then departs from the biceps, goes obliquely inwards, and is flattened and contracted into a tendon, ſix inches from the knee, and getting round the head of the tibia, it comes forward to be inſerted into the tuber, at the head of that bone. At this place, the tendon grows broad and flat; it is expanded and as it were graſps the inner ſide of the knee; its upper edge is joined to the lower edge of tendon of the gracilis, ſo that the ſartorius, gracilis, and ſemitendinoſus are implanted like one muſcle; and this tendinous expanſion ſeems like a capſule, for encloſing the heads

of the tibia and femur, and for ſtrengthening the knee joint. The ſemitendinoſus bends the leg.

CLXXVIII. The SEMIMEMBRANOSUS has its name from the muſcle, which is flat, thick, and fleſhy, beginning and ending with a flattened tendon, ſomewhat like a membrane, but infinitely thicker and maſſier than ſuch name ſhould imply.

It ariſes from the tuber iſchii, before the ſemitendinoſus and biceps. It ariſes a broad, thin, and flat tendon, of about three inches in length. It becomes fleſhy and thick in its middle, but it ſoon becomes thinner again, and terminates in a ſhort tendon, which, gliding behind the head of the tibia, is inſerted there *.

This muſcle has little connection with any other. It lies under, or more particularly ſpeaking, on the inſide of the ſemitendinoſus, and the two together form the innner hamſtrings. The hamſtring muſcles contribute alſo to another motion. Though when extended, the tibia cannot roll, yet when we ſit with our knees bent, it can roll ſlightly; and ſuch rolling is accompliſhed by theſe muſcles. All theſe muſcles which bend the leg, and which conſequently extend the thigh at the ſame time, are muſcles of great power, becauſe they ariſe in one common point, the tuber iſchii, and that point is very far diſtant from the centre of motion.

There is ſtill one ſmall muſcle, a flexor of the leg, which performs this rotation during the bent ſtate of the knee, with moſt particular power.

CLXXIX. The MUSCULUS POPLITÆUS, which is ſo named from its lying in the ham,, is a ſmall triangular muſcle, lying acroſs the back part of the knee joint, very deep under the hamſtrings, and under the muſcles of the leg.

* The two tendons of this muſcle, the membranous tendon at the head, and this ſmaller one by which it is inſerted, ſtand ſo obliquely, that the muſcular fibres betwixt them muſt be very oblique; for the membranous tendon deſcends low upon the back part or edge, and the tendon of inſertion begins high upon the fore edge of the muſcle.

Its

Its origin is from the outer condyle of the thigh-bone, and from the back part of the capſule of the joint. Its tendon is ſhort and thick, but of no great extent. It paſſes fleſhy behind the knee joint; and it is inſerted broad into a ridge on the back part of the tibia; ſo that by its ſmall origin and broad inſertion, it is a fan-like muſcle, its upper fibres being almoſt tranſverſe, and its lower fibres nearly perpendicular. Beſides bending the leg, it is uſeful by pulling aſide the capſule to prevent its being caught.

CLXXX. The BICEPS CRURIS, ſo named from having two heads, a long and ſhort one, lies immediately under the ſkin, in the back part of the leg, running down from the pelvis to the knee, to form the outer hamſtring.

It is the ſingle flexor on the outſide of the thigh. Its origin is from the outer part of the tuber iſchii, by a tendon of an inch and a half in length. And this tendon is, in its origin, cloſely united with that of the ſemitendinoſus for two inches, or at leaſt the whole length of the tendon. After a ſhort, but very thick fleſhy belly, it degenerates into a tendon, eſpecially on its back part; and this tendon, which begins above the middle of the thigh, is continued the whole way down.

About one-third down the bone is the beginning of the ſecond, or ſhort head, which has its origin all the way down the linea aſpera, to the line above the outer condyle of the thigh-bone; and here it is ſomewhat connected with the origin of the vaſtus externus muſcle, and the inſertion of the glutæus magnus. The tendons of the two heads are joined a little above the inner condyle, and go outwards to be inſerted into the outer part of the head of the fibula, forming the outer hamſtring.

Its inſertion ſurrounds the head of the fibula, and a ſmall portion alſo ſinks betwixt the bump of the fibula, and the inner head of the tibia, to be implanted into it alſo.

This muſcle, like the oppoſite ones, ſerves for bending the leg. The ſhort head ſimply bends the leg.

The long head assists the short one in bending the leg, and is a also muscle of the thigh.

The muscles of the foot are six EXTENSORS and two FLEXOR MUSCLE.

EXTENSORS.

GASTROCNEMIUS vel GEMELLUS,
PLANTARIS,
GASTROCNEMIUS INTERNUS vel SOLEUS,
TIBIALIS POSTICUS,
} lying on the back part of the leg.

PERONEUS LONGUS,
——— BREVIS,
} on the outside of the leg.

The FLEXORS are,

The TIBIALIS ANTICUS,
The PERONEUS TERTIUS,
} lying on the fore-part of the leg.

CLXXXI. The GASTROCNEMIUS is often divided into three muscles, named GASTROCNEMII or GEMELLI. But, far from counting thus, we should rather favour the arrangement of Douglas, who couples this with the next muscle, as forming a quadriceps, or two muscles joined with two heads each, and he calls it the EXTENSOR SURALIS.

The GASTROCNEMIUS is the great muscle of the calf of the leg, its two heads are two very large and fleshy bellies, which arise from the tubercles of the thigh-bone. The inner head is the larger, and arises by a strong tendon from the back of the inner condyle, and a little way up the rough line; and it has also a strong adhesion to the capsular ligament of the knee.

The outer head is shorter than this: It arises, in the same way, from the outer tubercle of the thigh-bone; and the two muscles meet and run down together, forming the appearance of a rapha, by the direction of their fibres; but the two bellies continue distinct till they meet in the middle of the leg. They are distinct at their back part, but, at their fore-part, they are connected by a tendinous aponeurosis, or strong but flat tendon; and the two bellies being about the middle of the leg, united firmly, they form a large flat tendon, very broad at its beginning, which unites with that of the soleus a little above the ancle.

CLXXXII.

CLXXXII. Soleus. — This name is from its resemblance to the soal fish; and it is often named gastrocnemius internus. This, like the last muscle, has two heads, which arise from either bone.

One head arises from the bulb of the fibula, and continues to adhere to one-fourth of the upper part of the bone; another head arises from about three inches of the upper part of the tibia. The first of these heads is large and round; the second is smaller and round; they unite immediately; and a large fleshy belly is formed, with still a conspicuous division betwixt the flesh of the two heads. The great tendon begins about half-way down the leg, but still is intermixed with fleshy fibres till it approach the heel. A little below the middle of the leg, this tendon is united with the tendon of the gastrocnemius, to form the great back tendon, named tendo Achillis; and sometimes, though very rarely, chorda magna.

The tendon is large; it grows smaller as it approaches the heel; when it touches the extremity of the heel-bone, it expands to take a firmer hold.

In running, walking, leaping, &c. this muscle, with the extensors of the leg, are the principal agents. The external gastrocnemius has double power; for arising from the tubercles of the thigh-bone, it is both an extensor of the foot, and a flexor of the leg; but the gastrocnemius internus is a mere extensor of the foot, and both together have such strength, as often to break the tendo Achillis.

CLXXXIII. Plantaris. This muscle is named from a mistaken notion of its going to the planta pedis, or sole of the foot, to form the plantar aponeurosis, like the palmaris of the hand; but, in fact, it does not go to the sole, but is a mere extensor of the foot, inserted along with the tendo Achillis.

This long and slender muscle is situated under the gastrocnemius externus. It arises from the external condyle of the femur, wholly fleshy; it also has an attachment to the capsular ligament of the joint; after an oblique fleshy belly, of about three inches, it forms

its ſmall flat tendon. The tendon runs betwixt the inner head of the gaſtrocnemius and the ſolæus; and when the tendo Achillis begins, the tendon of the plantaris attaches itſelf to the inner edge, and fore-part of the Achillis tendon; it accompanies it down to the heel, running in a groove which ſeems made to receive it; and it is implanted with the tendo Achillis, into the inner ſide of the heel bone. It is often wanting.

The uſe of this muſcle is to truck up the capſule, in the great bendings of the knee joint, and to aſſiſt the gaſtrocnemii muſcles.

The PERONÆI muſcles are thoſe which ariſe from the fibula. They are named from their length being different; the PERONÆUS longus being as long again as the BREVIS, for it is one-half longer in its origin, the one riſing at the head, the other at the middle of the bone; and again it is one-half longer at its inſertion, going fully round under the foot to the oppoſite ſide, while the ſhorter peronæus ſtops at the ſide of the foot to be inſerted.

CLXXXIV. The PERONÆUS LONGUS is ſo named from its lying along the fibula. It ariſes partly tendinous, chiefly fleſhy, from the upper knob of the fibula, and from the ridge of the bone, down to within three inches of the ancle. It has another ſmall ſlip of a head from the upper part of the tibia, above where the fibula joins; it has alſo adheſions to the tendinous partition, which ſeparates this from the EXTENSOR DIGITORUM COMMUNIS and the SOLEUS.

Its tendon begins very high, above the middle of the leg, and it continues to receive the fleſhy fibres, almoſt at right angles in the penniform manner. The tendon is concealed down to about or below the middle of the leg. Then it is ſeen immediately under the integuments, and we can eaſily diſtinguiſh it through the ſkin, being that acute line or ſtring, which runs down behind the outer ancle, and which gives ſhape to that part.

In paſſing the outer ancle it runs down through a cartilaginous pulley, or annular ligament, which alſo

 tranſmits

tranſmits the peronæus brevis: it leaves the peronæus brevis on the ſide of the foot; and paſſing by itſelf in a groove of the heel-bone, it bends obliquely acroſs the arch of the foot, goes quite down to the oppoſite ſide, and is inſerted into the metatarſal bone of the great toe, and the great cuneiform bone on which it is founded. Under the eminence of the OS CUBOIDES, it ſuffers great friction, ſo as to be thickened to a degree of oſſification, and to reſemble a ſeſamoid bone. It is alſo thickened in a leſſer degree, as it paſſes the outer ancle; and in all this length, it is tied down by a ſtrong ligamentous expanſion.

It is a powerful extenſor of the leg; it alſo gives that obliquity to the foot, which is ſo handſome and natural, and uſeful in walking. This muſcle particularly turns down to the ground, the inner edge of the foot; ſo it preſſes to the ground the ball of the great toe, and that is the part which touches the ground, and which feels ſore after long walking, or violent leaping or running: It is by that part we puſh, in making a ſtep; ſo that this muſcle is perceived to be continually active in all motions of walking, leaping, running, and more particularly in dancing.

CLXXXV. The PERONÆUS BREVIS is like its fellow, except in length and inſertion. Its origin is from the ridge of the fibula, beginning about one third down the bone, and continuing its adheſion the whole way to the ancle. It alſo has adheſions to the tendinous partition which is betwixt it, and the common extenſor; ſo that theſe two muſcles are, by ſuch adheſions, very difficult to diſſect. It is ſmaller at its origin, but increaſes in its fleſhy belly as it deſcends; and it is fleſhy lower down than the peronæus longus. It is, like it, a penniform muſcle. The tendons of the two peronæi paſs together, by the outer ancle, in the ſame ring; but the tendons croſs each other; for the peronæus longus is in its belly more forward. The brevis lies under and behind it, quite covered by it, and yet the tendon of the brevis by creeping under the longus, gets

gets before it, juſt under the outer ancle: and from that it runs in a ſeparate groove, ſuperficially upon the outer edge of the foot, to be inſerted into the metatarſal bone of the little toe. In both muſcles, the tendon is upon the outer edge, and begins almoſt as high as the upper head of each muſcle. This tendon of the peronæus brevis is the ſhorter one, is ſmall where it paſſes through the pulley, and expands when it reaches its inſertion, that it may graſp the metatarſal bone firmly. The tendon of the longer muſcle alſo expands a little, and ſomewhat in the form of a hand and fingers, taking hold of two bones by three little heads.

This muſcle aſſiſts the former in extending the foot, and coincides well in its oblique action with the laſt; for as the laſt turned down the inner edge of the foot, this turns the outer edge upwards, which is exactly the ſame motion.

CLXXXVI. The PERONÆUS TERTIUS is a third muſcle, having its origin from the fibula; but as its tendon paſſes before the maleolus externus, and as it is inſerted into the outſide of the foot, it has a contrary action to the peronæus longus and peronæus brevis. The peronæus tertius lies on the fore-part of the fibula, and riſes from the middle of that bone, and down to near its lower head. Its tendon does not paſs into the ſame ſheath with the peronæus longus and brevis, but goes under the annular ligament on the fore-part of the ankle joint, to be inſerted into the root of the metatarſal bone, which ſuſtains the little toe. The action of this muſcle balances the connection of the tibialis anticus, and the two together bend the foot, that is, bring it to an angle with the leg.

CLXXXVII. The TIBIALIS POSTICUS is a penniform muſcle; its tendon goes round the cartilaginous pulley of the inner ancle.

It is named TIBIALIS from its origin, and POSTICUS from its place.

It ariſes from the back part and ridge of the tibia, from the oppoſite part of the fibula, and from the interoſſeous membrane below theſe; and it continues its at-

 tachment

tachment to the interosseous ligament, quite down to the ancle. It has also strong attachments to the surrounding tendinous partitions. Its fibres are all oblique and go to the middle tendon, which is in the heart of the muscle. About the middle of the tibia, this tendon begins to emerge from the fleshy belly; it grows gradually smaller, but still continues to receive flesh quite down to the ancle. It passes in the groove of the inner ancle, and is retained there by such a ligament as holds the peronæi. After passing the ligament, it expands in the hand-like form, to grasp the bones of the tarsus; and it is expanded much more than the peronæus, for it sends roots down among the bones both of the tarsus and metatarsus, so as to take hold first on the lower rough part of the naviculare in passing over it. Then it is implanted into the two first metatarsal bones, then into the calcaneum, and lastly into the os cuboides; and where it passes over the os naviculare, it is hardened into a sort of sesamoid bone. In short it is implanted in the sole of the foot by a tendon like a hand, which sends down its fingers among the tarsal and metatarsal bones, to take the surest hold. This muscle pulls the foot in, so as to put the toes together, and, when balanced by the peronæi, it directly extends the foot.

CLXXXVIII. The TIBIALIS ANTICUS crosses obliquely the fore-part of the leg. It arises from the fore-part and outside of the tibia. It begins just under the outer tuber, and continues its adhesion down two-thirds of the bone; then the tendon begins to be formed; and this muscle, like almost all the smaller ones of the leg, adheres to the tendinous partitions, and to the fascia, with which they are covered. The tendon begins almost with the origin of the muscle, but continues covered by the flesh, and not appearing till within four inches or so of the ancle, when it begins to pass obliquely over the leg, and having completed the crossing above the ancle, it goes under the annular ligament in a peculiar ring, it runs along the side of the foot, and is implanted into the os cuneiforme internum, and

and a ſmall production of the tendon goes forward to be inſerted into the metatarſal bone of the great toe.

This muſcle turns the great toe towards the leg, and when aſſiſted by the peronæus tertius directly bends the foot.

MUSCLES OF THE TOES.

The long muſcles of the toes are juſt four, two FLEXORS, and two EXTENSOR MUSCLES. The flexor muſcles lie upon the tibialis poſticus, or behind, betwixt it and the ſolæus. The extenſor muſcles again lie under the tibialis anticus, or at leaſt their heads are under it, and their bellies only appear from under it, about the middle of the leg.

The flexor tendons follow the tendon of the tibialis poſticus, over the pulley of the inner ancle into the hollow of the foot. The tendons of the extenſor muſcles keep with that of the tibialis anticus, and croſs over the fore-part, or riſing of the ancle, where the tibia is united with the aſtragalus. And in diſſection, we muſt follow theſe in an oppoſite order to that in which they are deſcribed, for next to the fore-part of the ſolæus is, 1ſt, the FLEXOR POLLICIS; 2dly, the FLEXOR DIGITORUM; and 3dly, the TIBIALIS POSTICUS.

CLXXXIX. The FLEXOR LONGUS POLLICIS is ſmall and pointed at its origin, and ariſes fleſhy from three-fourths of the fibula, to within an inch of the outer ancle. It grows thicker and larger as it deſcends, and adheres to the tendinous partitions of the tibialis poſticus, and of the peronæi. Its tendon can be ſeen only about an inch above the joint of the ancle. It paſſes down behind the inner ancle, where it is bound in a ſort of annular ligament. It there paſſes under the heel-bone, in the arch of the foot, betwixt the bones and the abductor pollicis; it then glides into the channel made by the two heads of the flexor pollicis brevis; it then paſſes betwixt the two ſeſamoid bones at the root of the great toe; it then goes forward in a ſheath, to be inſerted into the laſt

last bone of the great toe, at which implantation it is enlarged.

Its office is to bend the great toe; but it is also continually useful at every step in extending the foot, or in keeping the toe firm to the ground, while the gastrocnemii raise the heel; and therefore we should not be rash in cutting away the great toe, for in it consists not the strength of the foot only, but of the leg.

CXC. The FLEXOR LONGUS DIGITORUM PEDIS is named in addition, the PERFORANS, because, like the perforans of the hand, it runs its tendons through the split tendon of a smaller muscle, which is lodged in the sole of the foot. It is named also FLEXOR COMMUNIS, although there be less reason here, where there are no flexors for the individual toes, than in the hand, where there are separate flexors for the individual fingers.

It arises from the back part of the tibia, its whole length, that is, from the end of the poplitæal muscle, and from the septum tendinosum, by which it is divided from the tibialis anticus, which lies immediately before it; and it continues this origin from the tibia down to within three inches or so of the ancle. Its origin is not easily separated before from the tibialis posticus, nor behind from the flexor pollicis.

The tendon is not formed till near the ancle, (within two inches of it), and the flesh still accompanies it quite down to the joint. It crosses the tendon of the tibialis posticus behind the ancle joint, and goes forward in the groove of the os calcis, tied down by a sort of capsule, or annular ligament. In the arch of the foot, it crosses the tendon of the flexor pollicis, from which it receives a slip of tendon; and thus the office of either is assisted by the other, and could be wholly supplied by it; it then passes over to the middle of the sole, and growing flatter and thicker, divides into four flat tendons. These go forward, diverging till they arrive at the ends of their metatarsal bones, then they emerge from the aponeurosis plantaris, along with the common short flexor. Now both these tendons run under a ligamentous sheath, and are included in it under the first

and ſecond bones of the toes; and having perforated the ſhort flexor oppoſite to the ſecond joint, they are finally inſerted into the root of the third or laſt bone of each toe. Theſe tendons, like the correſponding ones of the hand, ſeem to be ſlit with a ſort of longitudinal fiſſure.

The proper uſe of this muſcle is to bend the four leſſer toes, to bend all their joints, but more peculiarly the laſt bone; and alſo to extend the foot, keeping the point of the toes to the ground, conſequently aſſiſting the gaſtrocnemii, and all the muſcles uſed in walking, &c.

CXCI. The MASSA CARNEA JACOBI SYLVII, or PLANTÆ PEDIS, lies in the ſole of the foot; it is a ſmall body of fleſh, naturally connected with the flexor longus. The maſſa carnea ariſes from the lower part of the heel-bone, in two diviſions, one (the external one) tendinous, the other fleſhy. It is, upon the whole, pretty nearly of a ſquare form; it joins the tendon of the flexor longus, before its diviſion into tendons for each toe, and by the advantage with which it acts in conſequence of its origin from the heel-bone, it muſt be of great aſſiſtance to the flexor. It is more generally conſidered in the light of a ſupplementary muſcle; by ſome, it is conſidered as a diſtinct muſcle, and by others, as the origin and firſt beginning of the lumbricales pedis.

Thus Cowper conſiders the maſſa carnea, and the lumbricales, as one and the ſame: that the maſſa carnea joins the tendon, covers it with its fleſh, continues fleſhy along the common tendon, till at the bifurcation it alſo parts along with the four tendons, into four ſmall fleſhy muſcles, which are called lumbricales.

Albinus, again, paints the maſſa carnea diſtinctly terminating at the common tendon, and the lumbricales as ariſing diſtinct from each of the divided tendons.

CXCII. The FLEXOR BREVIS DIGITORUM is alſo named the flexor ſublimis or perforatus. It ariſes from the lower part of the heel-bone, or the bump upon which we ſtand. It ariſes by very ſhort tendinous fibres, and being placed immediately under the plantar aponeu-

roſis,

rosis, it takes hold of it, and also of the tendinous partitions betwixt it, and the two abductors of the small and of the great toe, which are on either side of it. Under the metatarsal bones, it divides itself into four heads; their tendons begin earlier upon the side next the foot; they grow round, emerge from betwixt the dentations of the plantar aponeurosis; they then pass into the vagina, or sheath of each toe; and on this, the first phalanx, they lie over the tendons of the long extensors. About the root of the first bone, they divide into two little bands, which form a split (like the perforatus of the fingers) for the passage of the long tendon.

The long tendon passes through it upon the second joint of the toe, and immediately after the perforated tendon fixes itself by the two forks to each side of the second bone, or phalanx of the toe.

Its use is to bend the first and second joints of the toes, but most peculiarly the second. The obliquity of the long flexor is exactly balanced by a corresponding obliquity of the short flexor; for the tendon of the long flexor coming round the inner circle, runs obliquely outwards to reach the toes, while the short flexor coming from the heel, which is towards the outer edge of the foot, runs in a like degree obliquely inwards, and meets the other at an acute angle near the toes.

CXCIII. The LUMBRICALES must be dissected after the short flexor. They need no description, since they exactly correspond with those of the hand. They rise, like them, in the forks of the flexor tendons. They, like them, pass through the digitations of the aponeurosis. They pass on to the first bone of the toes, and, like the lumbricales of the hand, creep over the convexity of the bone, to be united along with the tendons of the extensors. Their insertion is always at the side of the toe next the great toe, and their use is to bend the first joint of the toes, and to draw them towards the great one, making an arch in the foot, and assisting the transversalis pedis. The EXTENSOR BREVIS lies most superficially upon the sole of the foot, having its origin from the

the inner ſurface of the aponeuroſis. The MASSA CARNEA lies deeper, having no origin but from the tip of the heel-bone, and being ſoon implanted into the tendon of the long flexor. The LUMBRICALES again riſe from the tendons of the long flexor, beginning juſt where the maſſa carnea ends in it; and the LUMBRICALES are the flexores primi internodii; the SHORT FLEXOR MUSCLE, the flexor ſecundi internodii; the LONG FLEXOR, the flexor tertii internodii digitorum.

EXTENSORS OF THE TOES.

CXCIV. The EXTENSOR LONGUS DIGITORUM PEDIS is very difficult to diſſect, from its numerous adheſions.

It ariſes properly from the head of the tibia, at its outer and fore-part, juſt under the knee; but it has alſo ſtrong adheſions to the inner ſurface of the faſcia, to the tendinous partitions betwixt it and the tibialis anticus before and betwixt it, and the peronæi behind, and alſo to the interoſſeous ligament, and to the edge of the fibula. Its ſmall origin ſoon becomes thick, and is divided even from the beginning very perceptibly into three diſtinct portions. Theſe ſoon form three round tendons, which go obliquely inwards, paſs under the annular ligament of the ancle, and run in a ring of it, peculiar to them and the peronæus tertius. They then traverſe the two bands of the annular ligament, upon the fore-part of the foot, and now they change their direction a little, and go from within outwards, and diverge towards their proper toes. There are three portions of muſcle, and four toes to be moved; the firſt portion divides its tendon into two, at the joint, ſo that the firſt portion ſerves both the firſt and ſecond toe, the ſecond the third toe, and the third ſerves the fourth toe. Here the tendon of the long extenſor receives four other tendons; firſt, of the interoſſei externi; ſecondly, of the interoſſei interni; thirdly, of the long flexor; fourthly, of the lumbricales; and theſe form a very large ſheath, quite ſurrounding the toe.

Theſe

These do not only, like other extenſors, extend the toes, but alſo, by the divergence of the tendon, expand them, or ſeparate them one from another.

CXCV. The EXTENSOR DIGITORUM BREVIS is ſo connected with the extenſor longus, that it is natural to deſcribe them together. It is placed juſt where the buckle lies, upon the riſing of the foot, having its origin from the heel-bone, and running obliquely inwards.

Its origin is from the outer ſide, and fore part of the heel-bone, and alſo from part of the annular ligament. It is ſmaller where it ariſes by a ſhort tendon from the heel-bone, but it gradually encreaſes in ſize: it divides early into four heads, which are muſcular, and very diſtinct; the two inner of which are larger, the two outer more ſlender: each head has already formed an oblique tendon under its fleſh, which begins to appear naked about half way down the metatarſal bones. Theſe tendons croſs thoſe of the long extenſor, and paſs under them nearly about the end of the metatarſal bones. Then one is implanted into the firſt bone of the great toe, on the inſide of the long tendon under which it had turned. The ſecond, third, and fourth tendons are inſerted into their reſpective next toes, and the little toe is left without one. The three laſt of theſe tendons form a ſort of ſlit, the two ſides of which paſs along the ſides of the toes, ſurrounding the long tendon, ſomething like a perforatus; ſo that the three laſt tendons are inſerted along with the long tendons into the laſt bone of the toes.

The obliquity of this ſhort muſcle counteracts the obliquity of the long; and it ſerves to extend and to ſpread the toes, and to pull them away from the great toe.

CXCVI. The EXTENSOR POLLICIS PROPRIUS is a very ſlender muſcle, running from the top of the leg to the ſecond joint of the great toe. It ariſes from the fibula, a little below its head, grows tendinous as it approaches the foot, then paſſing under the annular

 ligament,

ligament, and the crofs ligament of the foot, it goes onwards to the fecond joint of the toe over the firft.

The fucceffion in which thefe mufcles lie, under and behind each other, is this: firft, the tibialis anticus, the outermoft mufcle, arifes from the fore part of the tibia, neareft the fore part of the leg, at the ridge of the tibia: fecondly, the extenfor pollicis lies immediately behind, and under the tibialis anticus; thirdly, the extenfor digitorum communis lies behind that: and fourthly, the peroneus tertius lies behind the common extenfor, like a part of that mufcle.

Thefe extenfor tendons are bound down by crofs bands, refembling the annular ligaments of the wrifts. The general fafcia of the thigh is continued over the knee, and down the leg: it is much ftrengthened at the knee, where it adheres to each point of bone; it defcends very thick and ftrong over the leg, binding down and ftrengthening the tibialis anticus and extenfor mufcles. The fheath grows thinner towards the ancle, but where it paffes over the joint it is fo remarkably ftrengthened by its adhefions to the outer and inner ancles, that it feems to form two diftinct crofs bands, which, going from the point of the outer ancle, acrofs the extenfor tendons, to the point of the inner ancle, forms a ftrong crucial ligament, refembling the annular ligament of the wrift; fo that this, which is called the CRUCIAL LIGAMENT of the ancle or foot, is plainly but a ftrengthening of the common fheath.

The remaining mufcles in the foot are the INTEROSSEI, which, in the foot, are found fingle on the lower furface or fole, but double, and two headed, upon the upper part of the foot. The ABDUCTOR, FLEXOR, and ADDUCTOR POLLICIS, which furround the great toe, fomething like thofe of the thumb; and the ABDUCTOR and FLEXOR MINIMI DIGITI, furrounding the little toe; and there is a fmall flip of mufcle, the TRANSVERSALIS PEDIS, which goes acrofs the fole of the foot.

CXCVII. The ABDUCTOR POLLICIS arifes, by very

ſhort tendinous fibres, from the knob of the os calcis, and alſo from a ligament which ſtretches from this knob to the ſheath which belongs to the tibialis poſticus; and it ariſes alſo from the tendinous partition betwixt it and the ſhort flexor of the toes; and although it forms a beginning tendon oppoſite to the cuneiform bone, the tendon is not naked, till it has reached the middle of the long metatarſal bone. It unites with the ſhort flexor of the ſame toe, and is inſerted into the firſt bone or phalanx of the toe at its root. Its uſe is to pull aſide the toe, and at the ſame time to bend it a little; it alſo curves the foot itſelf, for a joint, or any loaded part, is much better ſupported by muſcles than by ligaments; and this arch requires ſupport more than almoſt any other part.

CXCVIII. FLEXOR BREVIS POLLICIS. This muſcle is much ſhorter than the laſt, and lies betwixt the ABDUCTOR and the ADDUCTOR; it lies immediately upon the metatarſal bone.

Its origin is by a pretty long tendon from the heel bone, and from the OS CUNEIFORME EXTERNUM, by two ſeparate ſlips, from the heel-bone, being a full inch in length; it alſo adheres to the membranous partitions on either ſide of it. It is ſoon divided into two heads; one goes to the abductor, and the other goes to the adductor, to have the tendons inſerted with theirs, into the root of the firſt bone or phalanx. Theſe tendons contain the ſeſamoid bones; and the parting of the two heads makes a channel for the tendon of the long flexor to run in.

Its uſe is to bend the firſt joint of the great toe.

CXCIX. The ADDUCTOR POLLICIS is the third and laſt portion of the muſcle which encircles the great toe.

It ariſes from the heel-bone, by a tendon as long almoſt as that which it gives the abductor: It does not immediately ariſe from the heel-bone; but there is a ligament extended from the heel-bone to the os cuboides, and it ariſes from that ligament: this is the ligament, under which the tendon of the peroneus longus

 glides.

glides. The adductor is divided into two fleshy fasciculi or heads; these unite, and going obliquely inwards, are inserted either into the sesamoid bone, or directly into the first bone of the great toe.

C. The TRANSVERSALIS PEDIS extends transversely across the sole of the foot, at the head of the metatarsal bones; it is a very small muscle, and resembles a good deal the palmaris brevis.

It arises from the ligament which connects the bones of the tarsus together, and a small muscular belly is formed, which is inserted into the tendon of the ADDUCTOR POLLICIS.

Its use is said to be, to make a sort of gutter in the foot, by drawing the heads of the metatarsal bones together; but is it not evident, that this is one of many instances of muscles being a more perfect support than ligaments?—It is a support, having a sort of intelligence, contracting or relaxing, according to the necessity or degree of force; indeed, except this use, it is not easy to assign any, for there is very little occasion for hollowing the foot in this direction.

CCI. The ABDUCTOR MINIMI DIGITI, like the abductor pollicis, is a pretty long muscle, but very slender, lying on the outer side of the foot.

Its origin is from the knob of the heel-bone, and from the tendinous septum, which covers the flexor brevis: it forms two small tendons in the same direction: one small and shorter tendon is fixed into the metatarsal bone, at its root: The other goes forward, to be inserted into the root of the first bone of the toe, so that this muscle clearly performs both the offices ascribed to the other flexors. It bends the toe to which it belongs, and it extends and supports the tarsus in walking; and it carries the toe a little outwards, from which it has its name.

CCII. The FLEXOR BREVIS MINIMI DIGITI is next, and is almost the same muscle in place and office: it is an exceedingly small muscle; it just measures the length of the metatarsal bone, and arises from it. Its origin is from the root of the metatarsal bone of the little

little toe, and from the ligament by which that bone is connected with the os cuboides; its small belly runs the length of that bone, and it is implanted by a short tendon, into the root of the first bone of the little toe.

Its use is to bend the toe.

CCIII. The INTEROSSEI INTERNI are three small muscles, seated in the planta pedis, as the interossei manus are in the palm of the hand. Their slender tendons pass through the openings of the aponeurosis plantaris, and, going on the inside of the toes, are, like the lumbricales, inserted along with the extensor tendons.

These pull the toes towards the great toe, bend the first joint, and, extend the second and third.

CCIV. The INTEROSSEI EXTERNI are, like the corresponding muscles of the hand, four in number, and double-headed, and have been named bicipites. They rise from the metatarsal bones, on each side of them: each has some little variety in its origin or course; but it is far from being worth our while to describe each individually, as many do: it is sufficient to observe their origin, and that their tendons all meet the tendons of the long and short extensors of the LUMBRICALES, and of the INTEROSSEI INTERNI, upon the backs of the toes; so that the whole forms a web, aponeurosis, or sheath, which covers the upper part of the toe, and adheres to its point.

The office of these muscles is to extend the toes.

PLANTAR APONEUROSIS.—The palm and the sole are much exposed, and are specially defended by a thick tendinous aponeurosis. In the palm, there is the more reason to suspect expansion to proceed from the tendon of one muscle, because the tendon of the palmaris is inserted into it; yet that is not probable; for the tendon is very slender, and quite unfit for the generation of so broad a sheet of aponeurosis. In the foot, such an origin is still less probable; for the plantaris tendon does not terminate in the plantar aponeurosis, but is inserted into the heel-bone.

 The

The plantar aponeurofis arifes moft diftinctly from that part of the tuber of the heel-bone upon which we ftand: it is divided into three fheaths. Sabbatier makes a middle, external, and internal portion of the fame aponeurofis. Albinus alfo defcribes it as three diftinct aponeurofis, one for the middle of the foot; one for the abductor of the great toe; and one the aponeurofis of the abductor of the little toe; all connected together only by their edges. Cowper confiders it as a general expanfion from the plantaris; and it is from this prejudice that the mufcle has its name.

But its true origin is from that part of the knob of the heel bone on which we ftand. The middle and more pointed tendon arifes from the very point of the knob. The inner fafcia arifes from the infide of this; and the outer one from the outfide. And though thus divided into three heads, yet the whole origin is from the heel-bone. From this point the aponeurofis goes forward, expanding till it is as broad as the roots of the toes; fo that the whole has the fhape of a fandal; and as it expands, its fibres are fcattered, fo as to have a radiated appearance. Accordingly the part neareft the heel is thicker, while the broader part is thinner.

It goes forward like the fole of a fhoe, till having approached the heads of the metatarfal bones, it is divided into five heads, correfponding with the five knobs; and each of thefe heads again fubdivides itfelf into two bands, which, paffing on each fide of the heads of the metatarfal bones, is fixed into the fides, fo as to leave room for the paffing of the tendons, and nerves, and arteries.

Now this middle aponeurofis fends down a deep ftrong partition one each fide of it; which is the beft reafon that I know for making thefe three diftinct aponeurofis; for by thefe perpendicular partitions, the hollow of the foot is feparated into three diftinct chambers: under the middle one are concealed the tendons of the long flexors, with the lumbricales and fhort flexor mufcles: under the outer one the flexor and abductor of the little toe: and under the inner

one

one the adductor, flexor, and the abductors of the great toe.

The uſes of this great and very ſtrong aponeuroſis are: that it protects all the parts, the blood veſſels, muſcles, and nerves that lie under it: that it ſupports the arch of the foot, both in ſtanding and in motion, paſſing from heel to toe like a bow-ſtring acroſs its arch: that it binds down the muſcles, and conſequently ſupports and aſſiſts them in their ſtrong actions: that it gives origin, or part of their origin, to many of the muſcles; which, by their frequent and irregular adheſion to it, are very difficult to diſſect: that it forms openings or rings, in which the tendons of the other muſcles paſs.

CHAP. IX.

OF THE MUSCULAR POWER.

THAT contractile power which reſides in the muſcular or living fibre is a phenomenon the moſt wonderful and perplexing of all. When we cannot reach the true point, the mind too often condeſcends to the moſt trifling purſuits: and ſo, when the older phyſiologiſts could not underſtand the intrinſic nature of this muſcular power, they endeavoured to diſcover the ſize, the colour, and other external properties of the fibre; fooliſhly deſiring to know what, if known, could be of no avail. Colour was believed to be eſſential to the conſtitution of a muſcle: but in fowls, in amphibious animals, in fiſhes, in worms and inſects, through all the gradations of animals of different ſpecies or different ſizes, the colours of the muſcular fibre change. In fiſhes and in inſects, it is entirely white; even in the human body, it is not eſſentially red: the blood which makes the fibre red may be waſhed away. Then why ſhould we define a muſcle by that accidental property which it ſo often wants, and of which it may be ſo eaſily

eaſily deprived, while we may define it more truly by its contractile power, the only evidence of its nature, and its chief diſtinction in the ſyſtem; for the contraction of the iris conſtitutes its nature; it is a muſcle by truer marks than by its colour: and, by the ſame rule, the muſcles of the leaſt inſect are as perfect as the muſcles of a man.

Philoſophers of the laſt age had been at infinite pains to find the ultimate fibre of muſcles, thinking to diſcover its properties in its form; but they ſaw juſt in proportion to the glaſſes which they uſed, or to their practice and ſkill in that art, which is now almoſt forſaken. Some found the fibres to be of one equal ſize in all creatures, however various: others found them proportioned to the ſize, or age, or ſtrength of their ſubject; but even ſuch diſcrepancies are trivial to thoſe which, in one of the greateſt of theſe minute philoſophers, are found almoſt in the ſame page; ſometimes affirming the ultimate fibre to be greater or ſmaller, according to the ſtrength of the ſubject, and again making them of equal ſize, in the whale and in the inſect.

Others, leſs troubled about the ultimate ſize of theſe fibres, had conceived notions of their form, which, in the credulity of the times, roſe into the importance of doctrines, and, from the firſt raw conceptions of their authors, were finally proved by the microſcope, forſooth; and while one author was drawing his rhomboidal fibres, all conjoined in regular ſucceſſion, and another deſcribing them alſo from the microſcope, as conſiſting of ſix cylindrical fibres, involved in a ſpiral one, a third reckoned the fibres a ſucceſſion of ſpherical bodies: and Cowper thought that he was injecting with quickſilver, chains of bells jointed with each other. For the honour of the age, theſe vanities are forgotten now. And why, indeed, ſhould we ſeek the ultimate fibres of the muſcle, or ſtudy their forms, when the diſcovery could not advance us one ſingle ſtep in the knowledge of its nature or eſſence? What avails it that we have diſcovered (if we have really diſcovered) the ſhape of the particles of the blood; the wave-like fibres within

within the ſubſtance of the nerves; or the jointed appearance in the ſmaller fibres of muſcles? We do not underſtand the nature of the blood, the properties of the nerves, nor the contractile power of the muſcles at all better by this peculiar form of the internal ſtructure, than we do by the groſſer marks of their external form.

Phyſiologiſts have, by a late ſenſe of their own weakneſs, been at laſt humbled to this becoming, but unwilling acknowledgement, that this contractility of the muſcles is an original endowment of this living matter derived from the Creator, imparted in a way which we cannot know, and ſo attached to the organization of the muſcular fibre, that where its organization is deſtroyed, this power is loſt. We have reſigned the ſearch after a mechanical or phyſical cauſe, and ſeek only to learn the properties of this living power, and the excitements by which it is moved. To this end it is neceſſary to define this power, diſtinguiſhing it from thoſe feelings or motions which reſult from the nerves. The vis inſita, being that power which belongs to muſcles, is the ſource of motion and animal life. The vis nervea, being that property which is peculiar to nerves, is the ſeat of feeling, and the cauſe of voluntary motion, relating chiefly to the enjoyments and conſciouſneſs of life; for life and motion exiſt even in plants, and in many creatures, which, not having nerves, have neither conſciouſneſs nor enjoyment, and in which the place of feeling is ſupplied by a leſs perfect inſtinct, by this vis inſita, or ſome analogous inherent power.

This irritable power reſiding in muſcles, may be defined the property by which muſcles feel and re-act, upon certain ſtimuli being applied, without that feeling being conveyed to the ſenſorium, without a conſciouſneſs of action, without any other natural dependence on the ſyſtem than that, while certain orders of muſcles are obedient to their own ſtimuli only, as the heart to the blood, other orders of the muſcles are ready to receive the commands of the will. And above all, ſo

little

little dependent is this action upon the nerves, that it is as perfect in animals which have no nerves, and is for a time very perfect in the parts which have been severed from the systems to which they belonged. This power, inherent in the muscular fibre, belonging to its constitution, and not derived from without, is the vis insita, or irritability of Haller *, the vis vitalis of Goerter, the oscillation of Boerhaave, and the tonic power of Stahl. It is seen in the spontaneous and tremulous contractions of muscles when lacerated; as in wounds, when cut in operations, when entirely separated from the body; as in experiments upon animals, like that tremulous motion which we often feel in various parts of the body, without any evident cause, and independent of the will. Even when the body is dead to all appearance, and the nervous power gone, this contractile power remains; so that if a body be placed in certain attitudes, before it be cold, its muscles will contract, and it will be fixed in that posture till the organization yields and begins to be dissolved; it is the same inherent power by which a cut muscle contracts and leaves a gap. This is but a faint indication of that latent power, which can be easily excited to the most violent motions, and on which all the strength of the muscles depends: for the ligaments, tendons, bursæ of joints, and all those parts which have no living power, are capable of bearing the same weight when dead as when alive. But such is the connection betwixt the organization of a muscle and its contractile power, that the moment it dies its power is gone; and the muscle which could lift a hundred pounds while alive, cannot bear the weight of a few pounds when dead. This latent power

* The irritability of a muscle is, perhaps, more properly the vis insita, or inherent power called into immediate action, by the presence of stimuli; and as for the names of Tonic Power, Vital Power, and the rest, the terms are quite undefined, and may, perhaps, have referred rather to the combined effect of all the powers of life, and of all the properties of inanimate matter, of nervous sympathy, elasticity, and of muscular power combined.

may

may be brought into full action by various ſtimuli. The latent power itſelf is called vis inſita, the acting power put into action, or the proof of the vis inſita, upon applying ſtimuli, is called the irritability of muſcles. This irritability is ſo far independent of nerves, and ſo little connected with feeling, which is the province of the nerves, that upon ſtimulating any muſcle by touching it with a cauſtic, or irritating with a ſharp point, or driving the electric ſpark through it, or exciting with the metallic conductors, as of ſilver and zinc *, the muſcle inſtantly contracts ; although the nerve of that muſcle be tied, although the nerve be cut ſo as to ſeparate the muſcle entirely from all connection with the ſyſtem, although the muſcle itſelf be ſeparated from the body, although the creature upon which the experiment is performed, may have loſt all ſenſe of feeling, and have beeen long apparently dead. Thus, a muſcle cut from the limb, trembles and palpitates for long after ; the heart ſeparated from the body contracts when irritated ; the bowels, when torn from the body, continue their periſtaltic motion, ſo as to roll upon the table, ceaſing to anſwer to ſtimuli only when they become ſtiff and cold ; and too often in the human body, the vis inſita loſes the exciting power of the nerves, and then palſy enſues ; or, loſing all the governance of the nerves, the vis inſita, acting without this regulating power, falls into partial and general convulſions. Even in vegetables, as in the ſenſitive plant, this contractile power lives. Thence comes the diſtinction betwixt the irritability of muſcles and the ſenſibility of nerves ; for the iritability of muſcles ſurvives the animal, as when it is active after death ; ſurvives the life of the part, or the feelings of the whole ſyſtem, as in univerſal palſy, where the vital motions continue entire and perfect, and where the muſcles, though not obedient to the will, are ſubject to irregular and violent

* See a moſt ingenious diſſertation by my pupil Mr. Fowler, the firſt writer in this country, on this very intereſting novelty, where the operations of this new excitement are explained.

actions ;

actions; and it survives the connection with the rest of the system, as where animals very tenacious of life are cut into parts: but sensibility, the property of the nerves, gives the various modifications of sense, as vision, hearing, and the rest; gives also the general sense of pleasure or pain, and makes the system, according to its various conditions, feel vigorous and healthy, or weary and low. And thus the eye is sensible, and the skin is sensible; but their appointed stimuli produce no motions in these parts; they are sensible, but not irritable. The heart, the intestines, the urinary bladder, and all the muscles of voluntary motion, answer to stimuli with a quick and forcible contraction; and yet they hardly feel the stimuli by which these contractions are produced, or at least they do not convey that feeling to the brain. There is no consciousness of present stimulus in those parts which are called into action by the impulse of the nerves, and at the command of the will: so that muscular parts have all the irritability of the system, with but little feeling, and that little owing to the nerves which enter into their substance; while nerves have all the sensibility of the system, but no motion.

The VIS INSITA is a power that is in continual force, preserving the parts ready for their proper stimuli, whatever these may be: one set obeying their own peculiar stimuli chiefly, while others are obedient to the nervous power, and the influence of the will. The heart is stimulated by the quantity or quality of its blood; the stomach by the presence of food; the intestines by their contents: the urine stimulates the bladder; the venereal appetite stimulates the genital system; the fœtus stimulates the womb; and the voluntary muscles (if we may be allowed to guess at a thing so little known), are excited by the nerves, and so are obedient to the will; for, to our limited view, the nerves seem to be the sole messengers of these commands, and any stimulus to the nerves moves the muscles like the commands of the will. The absence of the due stimulus to each, or the presence of the ordinary stimuli in too great power,

will

will excite enormous and irregular motions, as fulneſs of blood in the heart, poiſons in the ſtomach, acrimonies in the inteſtinal canal, or the paſſions of anger or fear in the ſyſtem of the voluntary muſcles. The due ſtimuli preſerve their right tone and action; but theſe violent ſtimuli hurt their irritability, or moving power; the heart acts weakly after fevers; the appetite is languid after debauch; the limbs are weakened by labour; and the whole ſyſtem is ruined by exceſs. Thus, the functions by which the ſyſtem lives, the heart, the ſtomach, the bowels, and the womb, the various ſorts of veſſels by which the fluids are conveyed, are providently removed from the influence of the will; for theſe are the machines of the ſyſtem, whoſe motions could not ſtop, muſt not be interrupted, nor lowered, nor raiſed, but muſt move and act according to the needs of the ſyſtem. Not left to the irregularities or careleſſneſs of voluntary motions, they are governed each by its own peculiar ſtimulus, and act in a continued and equal courſe.

Thus, there are in the body two living powers, which are as cauſe and effect in all the motions of our ſyſtem. The NERVES ſtand as an intermedium betwixt all external objects and our general ſenſe; by the impreſſions through theſe come pleaſure and pain, and all the motives to action; by the will, returned through the nerves, all voluntary motions enſue. Thus, are the nerves, as internuncii, betwixt the external impreſſion and the moving power. But nerves were never known to move under the influence of ſtimuli; the moving power is another property of a diſtinct part of our body, having its own arrangement of particles, and its own peculiar form. All motion then proceeds from the joint operation of either power; the nerves convey the impreſſions, while the muſcles contain the power; and it is here, as in other natural effects, the external cauſe changes, while the inherent property, the ſubject of its operation remains the ſame. The nervous power is the regulator of the ſyſtem; it is the property ſuited

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to all the ſupports of life, upon which they act, and by which they maintain their power over our body; but is ſubject to continual changing: it riſes and it falls, is perfect or low; but the energy of the muſcle, which is to anſwer to this power, remains ever the ſame, while its oganization remains: the nervous power is exhauſted and languid; but the muſcular power is always perfect, always ready for the excitement of ſtimuli, or for the commands of the will.

There is (if we may be allowed any expreſſion ſo looſe and indefinite) the will of the ſyſtem, and the will of the mind; it is the will of the ſyſtem, that, through the medium of nerves of wide ſympathy and conſent, governs and leads in harmony all the conſenting functions of the body, and lowers and raiſes their powers, according to the weakneſs or ſtrength, or fullneſs or wants of the body; while the will of the mind commands thoſe voluntary motions, which it is its choice to perform. So natural ſeems that notion which has long prevailed, of an archæus, or preſiding ſpirit, which, like a latent inſtinct, regulates and preſerves the ſyſtem, prompts to what is right, and creates an averſion to what is wrong, and raiſes or allays the actions of the vital organs, preſerving the ſyſtem in health, and ſtriving againſt diſeaſe. The voluntary muſcles are put under the command of the will, while the involuntary muſcles, by which the vital organs move, are inſulated and mechanical, and depend leſs on our ſpiritual part: for life and exiſtence depend leſs on feeling, or that which is allied to our ſpiritual part, and more on the irritable and moving power; and it was fit that this irritable power ſhould be divided from our feelings and our will which are irregular and tranſitory, and apt rather to derange than to preſerve the ſyſtem.

How this diviſion is accompliſhed, we do not know in any ſurer way; but we ſee that the heart, the lungs, the ſtomach, and the inteſtines, have a proportion of nerves, ſo much lower than the muſcles of voluntary motion,

motion, that their very exiſtence has been denied. Yet there are nerves proper to the vital parts: the phrenic nerve goes to the diaphragm; the par vagum to the heart, lungs, and ſtomach; the ſymphathetic nerve to the heart, to the inteſtines and other viſcera of the abdomen: theſe nerves are appropriated and diſtinct. Now, this queſtion occurs: if the irritable power be in theſe organs, if they be endowed with the quality of feeling their own peculiar ſtimuli, and anſwering to their impulſes, what need is there for nerves? but they alſo have their nerves, that they may not want ſome living connection with that ſyſtem to which they belong: that they may flouriſh in its health, and languiſh in its diſeaſes; that they may act according to the needs, and be ſubject to the will of the ſyſtem; that the grand movers of the mechanical ſyſtem may be affected in their turns by the ſpiritual part, and thus the digeſtion, the circulation, the venereal appetite, and every vital power, are languid and depreſſed, or lively and perfect, according to the conditions of the whole: and how theſe functions are moved by anger, or joy, or fear, needs not be told. But the vital functions alſo loſe their action: "The heart acts weakly after fevers; the appetite is languid after a debauch; the limbs are weakened by labour; and the whole ſyſtem is ruined by exceſs." Theſe organs have leſs dependence on nerves, and ſo ſuſpicions ariſe, that the irritable power, the very baſis of life, may alſo fail; but how ſhould it fail? If the motions of our ſyſtem ceaſe, it muſt be either from the incapacity of the muſcles, or from the loſs of exciting power in the nerves. The nerves are liable to change, but the muſcle retains its power till its organization be deſtroyed. When the irritable power of a muſcle ceaſes, when the heart, for inſtance, begins to fail, whence can that loſs ariſe? Its power is not mechanically exhauſted, elſe from what ſource could it ever be renewed? It is not from any injury to its nerves; for the heart, when cut out from the body, may be wearied out with conſtant ſtimuli, till it ceaſe to act; and it

it will recover by reſt, without communication with the nerves: but it is perhaps ſuch a derangement as happens in a ſpring, which, being long bent, loſes of its elaſtic power: the arrangement of its particles ſuffers by ſtraining; they are compoſed by reſt: and if the elaſtic power be thus reſtored in an inanimate ſpring, much more ſhould the contractile power recover by reſt in the muſcular fibres of a living ſyſtem.

The VIS INSITA cannot be wearied nor exhauſted; ſo the heart is unwearied in its function, or if languid or too violent in its actions, that muſt be from the power of ſtimulus being lowered or increaſed, not from any change on the inherent power. The voluntary muſcles alſo are unwearied; and ſo, after great fatigue, we are ſenſible of cramps and irregular contractions, ſhowing that they are ſtill active, but more looſely governed by the nerves, and not ſo fully under the command of the will. But the NERVOUS SYSTEM is more ſubject to wearineſs and to decay: the ſenſes become tired; the feelings of the ſyſtem are exhauſted. It is from this failing of the nervous power, that violent exertions bring fatigue and pain: from this alſo that we need the refreſhment of ſleep; but during ſleep the heart, and all the involuntary muſcles, unwearied in their functions, proceed ſtill in the ſame regular and orderly courſe.

This irritability, or inherent power, not only keeps the muſcles ready, each for its peculiar ſtimulus, but preſerves a balance over the whole ſyſtem of the muſcles. We know that muſcles maintain a conſtant action, independent of the nerves. The muſcles of one ſide balance the oppoſite muſcles: and if the muſcles of one ſide be relaxed by palſy, the action of the oppoſite muſcles inſtantly appears: or if a limb be luxated, and its muſcles diſplaced, they perſevere in a violent and ſpaſmodic action, till they be reſtored each to its place. Have we not reaſon to believe, that if muſcles were abſolutely and entirely quieſcent, they could not be ſo inſtantaneouſly called into action; but that by this con-

tinual

tinual tenſion or tone, they more readily follow the commands of the will: that by this leſſer tenſion, they are prepared for greater action, and inclined to harmonize; for if all the muſcles were quieſcent, and one ſuddenly moved by the will, its antagoniſt would riſe into undue action, and the co-operating or aſſiſting muſcles would be unprepared. Whereas, by this continual tenſion of all the muſcles, one ſet is oppoſed to another, is conſenting with it, and is ready to co-operate with it, or to oppoſe it in the due degree: the mind has but to incline the power towards one ſet, and immediate and orderly motions enſue.

The NERVOUS INFLUENCE, again, is as a mere ſtimulus to the voluntary muſcles, as blood is to the heart, or the fœtus, or any foreign body to the womb. It loſes its influence over the ſyſtem faſter than the ordinary powers of life do; and the irritable ſtate of the muſcles continues long after the voluntary motion, or the power of excitement from the nerves is gone: for when we die ſlowly, this inherent power is exhauſted in the ſtruggles for life. If, while in perfect health, we are killed by a ſudden blow, the irritable power of the muſcles ſurvives the nervous ſyſtem many hours or days, and the fleſh trembles, and the abſorbents continue to abſorb; and often, as after ſuffocation, we can, by operating upon this poor remains of life, reſtore the circulation, re-animate the nervous ſyſtem, and recover that life, which ſeemed to have entirely left the body; and thus, the nervous influence, which ſeemed to animate the ſyſtem, and to be the prime mover and ſource of life, owes its reſtoration to that, which was thought to be but a ſecondary power. It is this remains of contractile power which fixes the dead body in whatever poſture it is placed: it is this remains of irritability, which preſerves freſhneſs in the animal which ſeemed dead, but which is really dying ſtill: for the moment this lingering portion of life is gone, the body diſſolves, and falls down; and ſo we judge of freſhneſs, by the rigidity of the fleſh, and foreſee approaching putrefaction, by its becoming ſoft. There

is no putrefaction in creatures ſuddenly killed, as in the accidents which happen to man, or in killing animals by a ſudden blow; in theſe the body continues freſh and ſuſceptible of ſtimuli long after death: but if this inherent power, this irritable nature of the fibre, be exhauſted before death, or in the moment of death, then does the body fall quickly into the condition of dead matter, running through thoſe changes, which are the only true marks of death. The fiſh, which is allowed to ſtruggle till it be dead; the ox, over-driven before it be brought to the ſlaughter; the animal killed by lightning, which ſuddenly explodes (if we may be allowed the expreſſion) all the powers of life; in theſe the contractile power is effectually exhauſted; no mark of irritability remains; putrefaction comes quickly on: and ſo in thoſe who die of the plague, of poiſon, of fevers, or of any ſudden and violent diſeaſe, which at once extinguiſhes life in the vulgar ſenſe, and robs the ſyſtem of that remnant of life, which the phyſiologiſt could produce to view; in all theſe caſes, the body becomes putrid in a few hours. If a body becomes putrid ſo early in warm climates, it is not merely becauſe putrefaction is favoured by heat; but it is becauſe heat exhauſts the vital power, and often a part of the body has loſt its organized power, and is almoſt putrid before the whole be dead. We find, that we are wrong in this, that when a body has loſt all feeling and motion, we pronounce it dead; the nerves indeed have ceaſed to do do their office; all feeling and conſciouſneſs is gone; but the mere animal power ſurvives the nerves, and through it the whole ſyſtem may be recalled into perfect life.

The powers and privileges of the nervous ſyſtem muſt not be ranked too high, nor valued too low: the perfect animal feels and moves by the nervous power; but ſurely its muſcles are actuated by a law of their own nature: the heart of the chick begins to move, before we dare preſume, that there is any organ for diſtributing this nervous power. The punctum ſaliens, is the heart of the chick: it is ſeen beating while the

body

body of the chick is but a rude, unformed, and gelatinous mafs; daily this active centre encreafes in ftrength and power; and it has a delicate feeling of ftimuli, and it quickly re-acts, fo as "to fly out into angry and perturbed motions," by the application of a ftimulus. It is excited by increafed heat, and languifhes when cold, till at laft it dies; then it ceafes to act, but ftill heat reftores it to life: and is not the proof ftronger in the grown animal, when we cut out the heart, which anfwers to ftimuli for fome time; at laft, feems to have its power exhaufted; it lies dead for fome time, till it again recovers its power? If this power proceeded from the nerves, how could it be renewed? but if it refide in the mufcle only, it may have been wearied, and may revive; its organization may have been deranged, and may be reftored by reft from ftimuli; and its parts may be compofed again, refuming their relative fituation, and their active arrangement and form; or though it may be infenfible to a ftimulus long applied, it may be ftill alive, even to a lower ftimulus of another kind; or it may awake again to the feeling of that ftimulus, which, by being too long applied, had loft its power *.

Senfibility depends upon the nerves; motion on the mufcles: both are equally admirable and infcrutable; the one conducing to all the enjoyments and all the fufferings of life, and to the intellectual faculties of man; the other being the chief fupport of animal life, and the fource of all the bodily powers.

As for the MECHANICAL POWERS, by which the contractions of the mufcular fibre is forwarded or retarded,

* There is a confideration which is not attended to: fenfibility and contractility are two diftinct endowments of the living body, the one the property of the nervous matter, the other of the mufcular fibre. When a fharp point is thruft into a mufcle, it is not the mufcular fibre which feels this injury, but the nervous matter in intimate diftribution with the proper fibre; and we have here, no more than on other occafions, a proof of mufcular contraction being the direct refult of a ftimulus to the mufcular fibre. Senfibility muft recede in a part, before that part be capable of receiving excitement, the contraction of the mufcle is therefore the conjoint operation of the nerves and mufcular fibres. C. B.

they are not what they have been believed; for we find few circumſtances in the origin, inſertion, or forms of muſcles, to favour their power, but many by which their power is abridged. There are certain points, where the length of lever gives an encreaſe of power. The maſtoid proceſs and the occiput, are as levers for the head; the ſpines of the vertebræ for the back; the olecranon for the arm; and the piſiform bone for the hand. The pelvis, and the jutting trochanters are as the levers for the thigh; the patella is a lever for the leg; the heel-bone is a lever for the whole foot; and the arch of the foot is as a lever for the toes. Theſe are not the whole, but they are, perhaps, the chief levers in the human body. In all the other implantations the muſcle is fixed, not behind the joint, but betwixt the joint and the weight that is to be moved. There is a greater loſs of power, when inſerted near to the joint; there is leſs loſs of power, when the tendon is inſerted far from the joint, and though we call ſuch inſertion a longer or ſhorter lever, there is always ſome loſs of power, and the true levers in the body are very few; far from providing mechanical forms to encreaſe the power, nature has provided ſuch a quantity of contractile power as to compenſate for any loſs of effect: ſo, in place of increaſing the effect of muſcles by levers, pulleys, and hinges, there is in almoſt every muſcle a great abatement of its force, by the form of the bones which it is deſtined to move; for muſcles loſe of their effect, by their being implanted, not behind the joint, but betwixt the joint and the body to be moved; by the inſertion of almoſt all muſcles being very oblique, with reſpect to the motions which they are to perform, ſo that half their force is loſt upon the immoveable end of the bone. Much force is loſt by a muſcle paſſing over many joints: one ſet of fibres in a muſcle hinders the action of adjoining fibres, and every degree of contraction takes from that muſcle an equal proportion of its power. Thus, every where in the human body, is power ſacrificed to the form and fitneſs of the part; that the joints may be ſmaller than the limbs; that the limbs may be proportioned to the body: and

and beauty and conveniency is gained by the facrifice of that power, which is not needed in the fyftem, fince the wifdom and goodnefs of the Creator has appointed a degree of force in the mufcles, more than proportioned to all this lofs of the mechanical power. Thofe who will admire the ways of Providence, fhould know how to admire! Nature is not feeking to compenfate for want of power, by the advantages of pulleys, and levers, and mechanical helps; nor is it in the forms of the parts, that the Infinite Wifdom is to be found: for among other gifts, fuch a portion of this fpirit is given to man, that he has ufed the pulleys, and levers, accelerations of motion, and all the mechanical powers that refult from it; he has invented valves of infinite variety, each perfect and true, to its particular office; he has anticipated all that he has found, in the mechanifm of the human body; but the living power which compenfates for the want of levers, which allows every where power to be facrificed to the beauty of form, which has ftrength in convulfive and violent actions, to break the very bones; this is the act of Infinite Wifdom, on which our admiration fhould chiefly dwell.

It is but the very elements of fo deep a fubject, that can be delivered here. I muft proceed to explain thofe provifions for eafy motion, which may be confidered as belonging to the mufcles and bones, and as preparing us for a knowledge of the joints.

CHAP. X.

OF THE TENDONS, LIGAMENTS, BURSÆ, AND ALL THE PARTS WHICH BELONG TO THE BONES OR MUSCLES, OR WHICH ENTER INTO THE CONSTITUTION OF A JOINT.

THE bones and mufcles themfelves are but the fmalleft part of that beautiful mechanifm by which the motions of the human body are performed; for the parts

parts by which the bones are joined to each other, or the mufcles fixed into the bones, are fo changed, and varied in their forms, according to the ufes of each part, as to give a natural and eafy fhape to the limbs, fecurity and firmnefs to their motions, and lubricity and fmoothnefs to the joints by which thefe motions are performed; and this apparatus deferves our attention, not merely that we may know the forms of thefe joinings, but that we may learn fomething of the nature and ufes of each part, and the various degrees of fenfibility with which each is endowed; for, from this kind of ftudy conclufions will arife, which may lead us to the knowledge of their difeafes, fuggefting the means of their prevention and cure.

There is a difference in the parts of the human body, according to the feveral ufes for which they are defigned; fome are vafcular and foft, others bony and hard; fome fenfible, and very prone to inflammation and difeafe, others callous and infenfible, having little action in their natural ftate, and little pronenefs to difeafe.—The greater part of the human body is merely inanimate matter, united into a moving and perfect whole, by the fyftem of the nerves which abound in each creature, according to its wants, and are diftributed in each fyftem according to the ufes and functions of every part. In fome places there is fuch a conflux of nerves, as form the moft delicate and perfect fenfe, endowing that part with the fulleft life; while others are left without nerves, almoft inanimate and dead, left feeling, where it ought not to be, fhould derange the whole fyftem.

The living parts of the fyftem are the mufcles and nerves; the mufcles to move the body, and perform its offices, each mufcle anfwering to its particular ftimuli, and moft of them obeying the commands of the will; the nerves to feel, to fuffer, and to enjoy, to iffue the commands of the will, and to move the mufcles to action: but ftill the mufcles have their own peculiar kind of life, fuperior to the nerves, and independent of them, always acting, always capable of greater action, always ready to receive the impulfe of the nerves. It is a power

a power which furvives that of the nerves, acting even when fevered from the general fyftem; and acting often on the living body, without the impulfe of the nerves, and fometimes in oppofition to the will. The dead matter of the fyftem joins thefe living parts, and performs for them every fubfervient office, forms coverings for the brain, coats for the nerves, fheaths for the mufcles, and tendons, ligaments, and burfæ, and all the apparatus for the joints; unites them into one whole by a continued tiffue of cellular fubftance, which, from part to part through all its various forms, has no interruption, and fuffers no change, but ftill preferves its own inanimate nature, while it joins the living parts to each other. The tendons, ligaments, periofteum, and burfæ, are all compofed of this cellular fubftance, which, by its elafticity, binds and connects the parts, and, by its dead and infenfible nature, is lefs expofed to difeafe, and is a fitter medium of connection for the living fyftem.

OF THE FORMS OF THE CELLULAR SUBSTANCE.

Under various modifications and fhapes, the cellular fubftance performs moft important offices among the living parts:—1. It forms CELLS over all the body, which allow the parts to glide and move eafily, which contain the fluid that makes all the motion of parts more eafy and free, which ftore up fat to fill the interftices, to fupport the parts in their action, to give a plumpnefs to all the body, and to be re-abforbed for the needs and ufes of the fyftem. This cellular fubftance is peculiarly ufeful to the mufcles, dives in among them, keeps their fibres at fuch due diftance, that each may have its action, fupports and lubricates them; fo that perhaps the difference of ftrength, in health and difeafe, depends, at leaft, in fome degree, upon this fupport. The thinner halitus makes the play of the fibres eafy and free; and the fat not only fupports the fibres in their action, but lubricates them fo, that a want of it is painful, while a fuperabundance of it incumbers the body. And Haller feems

 to

to have believed, that a diseased increase of it might not only oppress, but almost annihilate the muscular fibre.

2. But it is still further essential to a muscle, that while it moves, it should neither be hurt itself, nor harm the surrounding parts. Therefore, where one muscle moves over another muscle, soft flesh upon soft flesh like itself, there can be no hurtful friction, and the cellular substance is loose and natural, preserving its common form. But where tendons rub upon tendons, or bones upon bones, or where tendons rub upon muscles, or upon each other, some defence is needed, and the cellular substance assumes a new form: The cells are run together into one large cell, with thicker coats, and a more copious exudation, so that, being more liberally bedewed with a gelatinous mucus, it prevents the bad effects of friction, and is called a BURSA MUCOSA, or MUCOUS bag. These mucous bags are placed under rubbing tendons, and chiefly about the greater joints; some are large, and others small; their glairy liquor is the same with that which bedews the cellular substance, or the cavities of the joints; and the provision of nature is so perfect, that the occasions which require bursæ seem to form them by friction, out of the common cellular substance.

3. It is often useful that an individual muscle should be enclosed in a tendinous sheath, to give it strength and firmness, and to preserve it in its shape. All muscles, or almost all muscles, form for themselves individual sheaths, such as are seen enclosing the supra-spinatus and infra-spinatus of the scapula, the biceps humeri, and most of the muscles of the leg and thigh; but it is especially necessary that the whole muscles of the limb should be enclosed in some stronger membrane than the common skin, both to give form to the limb, and strength to its muscles, and to keep the individual muscles in their proper places, which otherwise might be luxated and displaced. And so the trunk of the body, the arm, the thigh, the leg, are bound each with a strong, smooth, and glistening sheath, formed out of the cellular substance, condensed and thickened by continual pressure.

And

And this alſo is thicker and ſtronger, according to the need that there may be for ſuch a help; for it is weaker over the flat muſcles of the back, or of the abdomen, ſtronger on the arm, ſtronger ſtill over the ſtrong muſcles of the thigh. It is hardly to be diſtinguiſhed in the child; grows thicker and ſtronger as we advance in years and in ſtrength, and in the arms of workmen it grows particularly thick and ſtrong, encreaſing in the back, ſhoulder, or limbs, according to the particular kind of labour. Theſe are the membranes which, by encloſing the muſcles like ſheaths, are called the VAGINA, or FASCIA of the arm, the leg, the thigh, &c.

4. TENDONS or ropes were needed, for the muſcles could not be implanted thick and fleſhy into each bone, without a deformity of the limbs, and eſpecially of the joints, which would have been not unſhapely only, but which muſt have abridged them of their motions and uſes. Where a muſcle is not implanted directly into a bone, tendons are ſeldom required; and ſo there are no tendons in the heart, the tongue, the œſophagus, the ſtomach, inteſtines, or bladder. But where tendons paſs over bones, or traverſe the joints, their force is concentrated into narrower bounds; and long tendons are fixed to the ends of the muſcles, to pull the bones: Theſe tendons were once believed to be but the collected fibres of muſcles, gathered into a more condenſed form; by which condenſation, their properties of feeling and motion were loſt, while they became hard, white, and gliſtening; and it was believed, that parts which were fleſhy in the child, became tendinous in the adult. But we know by the microſcope, that the tendon is not truely continued from the fleſh; that the fibres of the tendon, and of the fleſh, are not in the ſame line, the fibres of all penniform muſcles running into their tendon, in a direction more or leſs oblique; and good anatomiſts have been able to ſeparate the tendon from the fleſh, without any violence, and with the bluntest knives.— Muſcles are irritable, and have nerves; tendons are quite dead, have no viſible nerves, have neither feeling nor motion, nor any endowment by which we ſhould believe them

them to be allied to the living parts of the syſtem; and many tendons, as the expanſion of the palmaris, may be unravelled into mere cellular ſubſtance.

5. The PERIOSTEUM is merely a condenſation of the common cellular ſubſtance, formed in ſucceſſive layers: and the tendons are of the ſubſtance of the perioſteum; they mix with the perioſteum, and are implanted into it. In diſſecting a child, we tear up the perioſteum along with tendons, and without hurting the bones; but in proceſs of time, the perioſteum, and conſequently the tendons, are inſeparably fixed to the bones. The perioſteum tendons, faſciæ, and burſæ mucoſæ, are all of one ſubſtance, and of one common nature; they are various modifications of that dead matter, which having but little vaſcularity, and no feeling, and hardly any diſpoſition to diſeaſe, is the fitteſt for its office, and bears the rougheſt uſage in our experiments, and the moſt violent ſhocks in the motions of the body, without any ſigns of feeling, and without falling into diſeaſe.

6. Theſe tendons muſt be bound firmly down, for if they were to riſe from the bones, during the actions of the muſcles to which they belong, the effect of contraction would be loſt, and they would diſorder the joint, ſtarting out in a ſtreight line from bone to bone, like a bow-ſtring over the arch of a bow. The ſame inanimate ſubſtance ſtill performs this office alſo; for the tendons of one muſcle often ſplit to form a ſheath or ring for the next, or their tendons, after taking hold of the bone, ſpread their expanſion out over all the bone, ſo as to form an entire ſheath for the finger and toe; or there is a wide groove in the bone which receives the tendons, and it is lined with a cartilage, and with a lubricated membrane; the membrane comes off from the lips of the groove, or from corners or edges of the bone, paſſes over the tendons, ſo as to form a bridge, or often it forms a longer ſheath, as in the fingers, or where the peronæi muſcles paſs behind the ancle, and thus the VAGINA or SHEATHS of the TENDONS are connected with the tendons, perioſteum, and other modifications of the common cellular membrane.

7. The

7. The periosteum which has run along one bone, leaves it at the head, and forming a bag for the joint, goes onwards to the next bone. Thus, the periosteum of all the bones is one continued membrane, passing from point to point; each bone is tied to the next by its own periosteum, and this membrane betwixt the end of one bone, and the beginning of the next, is so thickened into a strong and hard bag, as to form the capsule of the joint; and the periosteum is assisted in performing this office, by the tendons, fasciæ, bursæ, and all that confusion of cellular substance which surrounds the joint. The CAPSULE of the JOINT is then a firm and thick bag, which, like a ligament, binds the bones together, keeps their heads and processes in their right places, contains that glairy liquor, with which the heads of moving bones are bedewed, and prevents the adjacent parts falling inwards, or being catched betwixt the bones, in the bendings of the joints. The capsule of every joint proceeds from the periosteum, and is strengthened by the tendons; it is formed like these parts, out of the cellular membrane; and when a bone is broken, or its periosteum destroyed by any accident or disease, when a tendon snaps across, when a joint is luxated, and the capsule torn, the injury is soon repaired by a thickening of the cellular substance round the breach; and wherever a bone being luxated, is left unreduced, a new socket, new periosteum, new ligaments, and new bursæ, are formed out of the common cellular substance; and though the tendons may have been torn away from the head of the bone, they are fixed again, taking a new hold upon the bone.

8. There are other LIGAMENTS of a JOINT which prevent its luxation, guarding it at its sides, or round all its circle, according to its degree of motion; and those ligaments are of the same nature with the first, or bursal ligaments arise like them, from the periosteum chiefly, or indeed are truly but a thickening of the bursal ligament at certain points.

The universal connection of these parts is now sufficiently explained, since we have followed the several

forms

forms of cellular ſubſtance: 1ſt, Clothing the bones with a thick membrane, which, though inſenſible, and almoſt inanimate in its own nature, conveys blood veſſels, the means of life, to the bones, and is named perioſteum: 2dly, The ſame perioſteum, thickened and ſtrengthened by the adheſion of ſurrounding parts, ſo as to form the capſules for the joints: 3dly, The tendon alſo continued from the perioſteum, and not growing from the muſcle, but merely joined to it: 4thly, We ſee that ſmaller tendon, expanded into a thinner tendinous ſheet, as in the brawn of the leg where the ham-ſtrings (whoſe expanſion ſtrengthens the knee-joint), go down over the muſcles of the leg: 5thly, We ſee the perpendicular partitions of this faſcia going down among the muſcles, and dividing them from each other; and the cellular ſubſtance which lies under the faſcia, and immediately ſurrounds the muſcle, cannot be diſtinguiſhed from the inner ſurface of the faſcia itſelf: 6thly, And as for the burſæ, we ſee that they are formed wherever a tendon rubs over a bone. The upper ſurface of the burſa is formed by the tendon which rubs over the bone; the lower ſurface of the ſame burſa, is formed by the perioſteum of the bone which it defends; the ſides are formed by the common cellular ſubſtance. Its cavity appears to be merely an enlarged cell; and the burſæ mucoſæ, and capſular ligaments, are plainly of one and the ſame nature; their liquors are the ſame, they often open into one another naturally, or if not naturally, at leaſt it is no diſeaſe, ſince no bad effects enſue.

I muſt now explain more fully the conſtitution and nature of all the leſs feeling parts: For what I have ſaid might be thought to imply abſolute inſenſibility and total exemption from diſeaſe or pain; whereas, the ſenſibility of tendons, ligaments, burſæ, and joints, ſtands on the ſame footing with the feeling of bones: They are inſenſible in health; not eaſily injured; entering ſlowly into diſeaſe; but their diſeaſes are equally dreadful from their duration and from their pain: for by inflammation, their organization is deranged, their healthy conſiſtence

ſiſtence deſtroyed, and their ſenſibility excited in a dreadful degree.

The tendons of animals have been cut or pierced with embowelling needles; they have been pinched with nippers, and torn and cauteriſed; they have been burnt with a lighted ſtick, while the creatures neither ſtruggled nor ſhrunk from the irritation, nor ever gave the ſmalleſt ſign of pain. Oil of vitriol has been poured upon each of the parts belonging to a joint, and a piece of cauſtic has been dropped into its cavity, but ſtill no pain enſued; nay, ſome have been ſo bold, may I not ſay ſo vicious, as to repeat theſe experiments upon the human body, pinching, pricking, and burning the tendons of the leg, and piercing them with knives, in a poor man, whoſe condition did not exempt him from this hard treatment; who was ignorant of this injuſtice that was done to him; while his cure was protracted, and he was made a ſpectacle for a whole city. Without ſuch cruel and inhuman practices, we do not want opportunities of knowing, that, in the human body alſo, the tendons and burſæ have no acute feeling. When we cut open a faſcia or tendinous membrane, there is little pain: when (as in amputation) we cut the ragged tendons even and neat, there is no pain: when we ſnip with our ſciſſars the ragged tendons of a bruiſed finger to cut it off, the patient does not feel: when we ſee tendons of ſuppurating fingers lying flat in their ſheaths, we draw them out with our forceps, or touch them with probes, without exciting pain. In the old practice of ſewing tendons, there was ſome danger, but no immediate pain: when we cut down into the cavity of a joint, ſtill the pain is but ſlight. In a luxation, there is comparatively little pain. There is no pain when the ligament of the patella is broken away from the tibia, nor when the great Achillis tendon is torn. There is but little pain in the moments of thoſe accidents which appear ſlight in the time, but which turn out to be the moſt dreadful ſprains. Yet, after rupure of the patella, the knee inflames and ſwells: after rupture of the Achillis tendon, there is ſwelling and inflammation, with ſuch adheſion

of the parts as makes the patient lame: after the slightest sprain, such inflammation sometimes comes on as destroys the joint. There is but little pain when we first make an opening into any joint; yet it often brings on such pain and fever, that the patient dies. In short, every thing conspires to prove, that though in wounds of the less feeling parts, there is indeed future danger, there is no immediate pain. Still there are many accidents which prove to us, that even in health, the joints are not entirely exempted from pain: a smart stroke on the knuckles, or a blow on the elbow, or a fall upon the knee, are not perhaps the purest instances of feeling in joints; for such blow may have hurt some external nerve; but when a small moveable cartilage forms within the joint of the knee, though it be small and very smooth, and lodged fairly within the cavity of the joint, it often gets betwixt the bones, causing instant lameness; the moment it causes this lameness, it brings dreadful pains: the pain, the lameness, and all the feeling of inconveniency subside the instant that this cartilage is moved away from betwixt the bones; and the joint continues easy till this moving cartilage chances again to fall in betwixt the heads of the bones. Even the pain from a blow upon the knee, for example, is plainly within the joint, and is caused by the force with which the patella is struck down against the ends of the bones, what indeed is a sprain, but a general violence and twisting of all the parts which compose the joint? These parts are of one common nature, and may be arranged and enumerated thus: A joint is composed of the heads of the bones swelling out into a broader articulating surface, and of a thin plate of cartilage, which covers and defends the head of each bone; sometimes of small and moveable cartilages which roll upon the bones, and follow all the motions of the joint, and, like friction wheels in machines of human invention, abate the bad effects of motion. There are mucous glands, or rather mucous bags, which convey a lubricating fluid: and there is a bursal ligament which forms the purse of the joint, binds the bones together, contains

tains the fynovia, and prevents the furrounding parts from being catched in the joint: There are leffer ligaments on the outfide of this, going along the fides of the joint, and paffing from point to point: There are great tendons moving over the joint, and burfæ, or mucous bags, which accompany thefe tendons, and prevent the violence which their continual rubbing might do to the bones. All thefe parts are of one conftitution and nature; we cannot fay that they are infenfible, for their feeling is only deferred; it is flow, but not the lefs fevere. The eye feels the inftant that a mote falls upon it; but the fkin does not feel a blifter till it has been fome hours applied; the ligaments and joints feel ftill lefs in the inftant that any injury is done: but as the inflammation of the blifter excites the feeling, and deftroys the fabric of the fkin, producing pain and derangement of its parts, the inflammation of joints, and of all the parts belonging to them, breaks up the organization of the part, evolves the feeling, and then in them alfo comes difeafe and violent pain. They are flow in entering into action, but, once excited, they continue to act with a perfeverance quite unknown in any other part of the fyftem. Their mode of action, whatever it may be at the time, is not eafily changed: if at reft, they are not eafily moved to action, and their exceffive action once begun, is not eafily allayed. The difeafes are infinite to which thefe parts are fubject. They are fubject to dropfical effufions; they are fubject to gelatinous concretions; they are fubject to flight inflammation, to fuppuration, to erofions of their cartilages, and to exfoliation of their bones, correfponding with the dropfies, fuppurations, and mortifications of the fofter and more feeling parts. Rheumatifm is an inflammation round the joints, with a flighter effufion, which is foon abforbed: Chronic rheumatifm is a tedious and flow inflammation, with gelatinous effufions round the tendons, and permanent fwelling and lamenefs of the joints. Gout, in a joint, is a high inflammation, with a fecretion of earthy matter into its cavity. The inflammation of tendons

is ſprain: effuſion of gelatinous matter round them is ganglion: ſuppurations in the tendinous ſheaths is whitloe: the inflammation of burſæ is falſe white ſwelling, not eaſily diſtinguiſhed from the true: the diſeaſe of the joint itſelf is either a dropſy, where the joint, though emptied by the lancet, is filled up again in a few hours, ſhowing how continual, and how profuſe, both the exhalation and abſorption of joints naturally is: or it is white ſwelling, which, next to conſumption, is the moſt dreadful of all ſcrophulous diſeaſes, which begins by inflammation in the joint itſelf, is marked by ſtiffneſs, weakneſs, loſs of motion, and pain; which goes on through all the ſtages of high inflammation, dreadful pain, deſtruction of cartilages, enlargement of bones, fœtid ſuppurations and ſpontaneous openings of the joints; which ſometimes ſtops by an effuſion of callus and concretion of the bones, forming a ſtiff joint, but which oftener ends in hectic fever, diarrhœa, morning ſweats, and extreme weakneſs; ſo that the patient dies, exhauſted with fever and pain.

BOOK III.

OF THE JOINTS.

CHAP. I.

JOINTS OF THE HEAD AND TRUNK.

JOINTS OF THE HEAD AND SPINE.

ALMOST every thing relating to the heads and proceſſes of the bones, and every propoſition concerning the motions which they have to perform, has been already explained, anticipating much of the anatomy of the joints: and the principles of motion mentioned in deſcribing the bones, ſhall form the chief propoſitions on which my deſcriptions of joints ſhall be arranged, ſeeking that method chiefly by which the joints may be eaſily and rapidly explained; for it is a ſubject on which volumes might be beſtowed, and not in vain.

We may compare, in the following order, the chief motions of the head and trunk. The head is ſo placed upon the oblique ſurfaces of the atlas, that it cannot turn in circles; but at that joint all the nodding motions are performed. The atlas reſts ſo upon the dentatus, that there all the turning motions are performed. The neck and loins have their vertebræ ſo looſely framed, with ſuch perpendicular proceſſes and eaſy joints, that there all the bending motions are performed, while the back is fixed, or almoſt fixed, by its connection with the ribs, and by the obliquity and length of its ſpines; and though, upon the whole, the ſpine turns many degrees, yet it is with a limited and elaſtic motion where the whole turning is great, but the movement of each individual bone is ſmall.

To ſecure theſe motions, we find, 1. The occipital condyles received into hollows of the atlas, where the oblique poſition of the condyles ſecures the joint, the occipital condyles looking outwards, the articulating ſurfaces of the atlas looking towards each other, the occiput ſet down betwixt them, ſo as to be ſecured towards either ſide, and the obliquity of the joint being ſuch withal as to prevent the head from turning round. Theſe joints of the occiput with the atlas, are, like the greater joints of the body, ſecured with regular capſules, or bag-like ligaments, for each condyle, each riſing from a rough ſurface on the vertebræ, and being fixed into a roughneſs at the root of the condyle. 2. We find a flat membranous ligament, which extends from the ring of the atlas to the ring of the occipital hole, cloſing the interſtice betwixt the occiput and the atlas: It is confounded at the ſides with the capſules of the articulating proceſſes; is very ſtrong before; and at the middle ſhort point of the atlas it ſeems a diſtinct ligament, which is ſtrong only at this point, and very lax and membranous behind *. 3. We find the atlas tied to the dentatus, by a more complete order of ligaments. Theſe are, 1*ſt*, (as betwixt the atlas and dentatus) regular capſules, or bags, fixing the condyles of one vertebræ to the condyles of the other. 2*dly*, A croſs ligament † which, croſſing the ring of the firſt vertebræ, makes a bridge, embraces the neck of the tooth-like proceſs, and ties it down in its place. 3*dly*, A ſmooth and cartilaginous ſurface all round the root of the tooth-like proceſs, where this tooth of the dentatus turns in the ring of the atlas, and is bound by the ligament; and this rolling of the atlas upon the axis of the dentatus is ſo fair and proper a joint, that it alſo is all included in a capſular ligament.

* This is part of what Winſlow called LIGAMENTUM INFUNDIBILIFORME, a FUNNEL-LIKE LIGAMENT, joining the firſt vertebra to the occiput.

† Viz. LIGAMENTUM TRANSVERSALE, or TRANSVERSUM; and what are called the APPENDICES of the TRANSVERSE LIGAMENT, are merely its edges, extending upwards and downwards, to be fixed into the dentatus, and into the occipital hole, ſo as to encloſe the tooth-like proceſs of the dentatus in a capſule.

ligament. *4thly*, The point of the tooth-like procefs having threaded the ring of the atlas, almoft touches the occipital hole; and there another ligament ties it by its point to the occipital hole *.

All the other vertebræ have another kind of articulation; to which the occiput, atlas, and dentatus are the only exceptions, for their motions are particular, and quite different from the reft. The atlas and dentatus bend, turn, and roll by connections refembling the common joints of the body; but the other vertebræ are united, each by its INTERVERTEBRAL SUBSTANCE, to the bones above and below; they are alfo united by their articulating proceffes to each other: each articulating procefs is held to another by a diftinct capfule; each intervertebral fubftance is fecured, bound down, and ftrengthened by ftrong ligaments; for the intervertebral fubftance, which of itfelf adheres very ftrongly to the periofteum, and to the rough focket-like furface upon the body of each vertebra, is further fecured by a fort of crofs ligament, which go from the rim or edge of one vertebra to the edge of the next, over the intervertebral fubftance; and fo, by adhering to the intervertebral fubftance, they ftrengthen it. Thefe ligaments crofs each other over the interftice betwixt each vertebra, and are very ftrong. They are very regular, beautiful, and fhining, and are named INTERVERTEBRAL LIGAMENTS.

The fpine is further fecured by a general ligamentous or tendinous expanfion, which goes over the fore-parts of all the vertebræ, from top to bottom of the fpine. It begins at the fore-part of the atlas; it almoft paffes the body of the dentatus, or is but very flightly attached to it. It is at firft pointed, fmall, and round; it begins

* There are two flat ligaments which come from about the neck or root of the tooth-like procefs, and which go obliquely upwards, to be fixed into the groove juft behind the lip of the occipital hole; but the ligament from the point of the tooth-like procefs is not what it has been fuppofed, a fair round ligament of fome ftrength: there is nothing more than a few ftraggling fibres of ligament going from the point to the occiput, though Euftachius has drawn it round and ftrong.

 to

to expand upon the third vertebra of the neck, ſo as to cover almoſt all its body. It goes down along the bones, chiefly on their fore-parts, and is but little obſerved on their ſides. It is weaker in the neck, where there is much motion: ſtronger in the back, where there is none; weaker again in the loins, where the vertebræ move; but ſtill on the bodies of all the vertebræ it is ſeen white, ſhining, and tendinous. We can diſtinguiſh all along the ſpine interruptions and faſciculi, or firmer bundles going from piece to piece of the ſpine; which faſciculi are indeed very ſeldom continued without interruption, further than the length of two or three vertebræ; yet the whole is ſo much continued, that it is conſidered as one uninterrupted ſheath, and is called the EXTERNAL or ANTERIOR VAGINA, or LIGAMENT of the SPINE *.

But ſtill the canal of the ſpine were left open and undefended, rough and dangerous to the ſpinal marrow, if internal ligaments were not added to theſe. The rings of the vertebræ are held at a conſiderable diſtance from each other, by the thickneſs of the intervertebral ſubſtance, and by the correſponding length of the oblique proceſſes; but this ſpace is filled up by a ſtrong flat ligament, which goes from the edge of one ring to the edge of another, and ſo extending from the articulating proceſſes, backwards to the ſpinous proceſſes, they fill up all the interſtice, complete the canal of the ſpinal marrow, and bind the bones together with great ſtrength †: Theſe are aſſiſted in their office of holding the vertebræ together, by a continuation of the ſame ligament, or of a ligamentous membrane connected with it, which runs all the way onwards to the ends of the ſpinous proceſſes, where they are ſtrengthened by acci-

* The LIGAMENTUM COMMUNE ANTERIUS, FASCIA LONGITUDINALIS ANTERIOR, FASCIA LIGAMENTOSA, &c. It is from this ligament in the loins that the crura diaphragmatis ariſe, with tendons flat and gliſtening like the ligament itſelf, and hardly to be diſtinguiſhed from it.

† They are named the LIGAMENTA SUBFLAVA CRURUM PROCESSUUM SPINOSORUM.

dental

dental fasciculi *; and in the middle vertebræ of the back, but not of those of the loins or neck, similar ligaments are found also betwixt the transverse processes †.

Next, there is another internal ligament, which is not interrupted from bone to bone, but runs along all the length of the spine, within the medullary canal, and it corresponds so with the external vagina, or anterior ligament of the spine, that it is called the POSTERIOR OR INTERNAL ligament ‡. It begins at the occiput, lies flat upon the back part of the bodies of the vertebræ; at the interstice of every vertebræ, it spreads out broad upon the intervertebral substance, doing the same office within, that the intervertebral ligaments do without. It is broader above; it grows gradually narrower towards the loins. Although it is called a vagina, or sheath, it does by no means surround nor enclose the spinal marrow, but is entirely confined to the covering of the bodies of the vertebra, never going beyond the setting off of the articulating surfaces, or the place where the nerves go out. It adheres firmly to the bones, and does not belong at all to the spinal marrow. It should rather be called a ligament for the bones, than a sheath for the medulla. The anterior ligament prevents straining of the spine backwards: this one prevents the bending of the spine too much forwards, and they enclose betwixt them the bodies of the vertebræ, and their intervertebral substances.

There is yet a third internal ligament, which belongs entirely to the neck; it is called APARATUS LIGAMENTOSUS COLLI; it begins from the edge of the occipital bone, descends in the canal of the vertebræ, is thin and flat, and adheres firmly to the body of each vertebra,

* These are named the MEMBRANÆ INTERSPINALES, and LIGAMENTA APICES SPINARUM COMITANTES. The ligaments which tie the points of the spines, running from point to point, make a long ligament, which stretches down all the spine.

† Called LIGAMENTA PROCESSUUM TRANSVERSORUM, and found only from the fifth to the tenth vertebra of the back.

‡ FASCIA LIGAMENTOSA POSTICA, FASCIA LONGITUDINALIS POSTICA, LIGAMENTUM COMMUNE POSTERIUS.

covering the tooth-like proceſs. The irregular faſciculi, or bundles of this ligament, ſtretch from bone to bone; and the whole of the apparatus ligamentoſus extends from the edge of the occipital hole to the fourth vertebra of the neck, where it ends. Its chief uſe is alſo as a ligament, merely fixing the head to the neck. The dura mater is within theſe, immediately encloſing the ſpinal marrow. The ligaments which I have juſt named, may be well enough allowed to be "at once ligaments for the bones, and a ſheath for the medulla." But there is no ſuch ſheath as that called ligamentum infundibiliforme by Winſlow; for either they are peculiar and diſtinct ligaments for the bones, ſuch as I have deſcribed, or they belong excluſively to the medulla, as the dura mater, which is indeed ſtrengthened at certain points, into the thickneſs of a ligament; but the only cloſe connection of the ſpinal marrow with the ligaments of the ſpine, is juſt at the hole of the occipital bone; and for a little way down through all the reſt of the ſpine, the connection is by the looſeſt cellular ſubſtance.

OF THE LOWER JAW.

THE LOWER JAW is, by its natural form, almoſt a ſtrict hinge, and the lateral motion in grinding is but very ſlight. The joint is formed by a deep hollow or ſocket in the temporal bone, by a ridge which ſtands juſt before the proper ſocket, at the root of the zygomatic proceſs, and by a long ſmall head, or condyle, which is placed acroſs the long branch, or condyloid proceſs of the jaw. Theſe form the joint, and the condyle, the hollow of the temporal bone, and the root of the zygomatic proceſs, are all covered with articulating cartilage. The joint is completed by a capſule of the common form, which ariſes from the neck of the condyle, and which is ſo fixed into the temporal bone as to include both the proper ſocket and the root of the zygomatic proceſs. Thence it is manifeſt, that in the motions of the jaw, this tranſverſe ridge is required as a part of its articulating ſurface; that the common and

leſſer

leſſer motions are performed by the condyle moving in the deepeſt part of its ſocket; that the larger and wider openings of the mouth are performed by ſuch depreſſion of the jaw as makes its condyle mount upon the root of the zygomatic proceſs. While the luxation of the jaw is a ſtarting forwards of the condyle, till it is lodged quite before and under the zygomatic proceſs, and the condyle ſtanding upon the higheſt ridge, is the dangerous poſition in which luxation is moſt eaſily produced.

To render theſe motions very eaſy and free, a moveable cartilage is interpoſed. We find ſuch cartilages in the joints of the clavicle, wriſt, knee, and jaw, becauſe the motions are continual and rapid. The moveable cartilage is thin in its centre, and thicker towards its edges, by which it rather deepens than fills up the hollow of the joint. It correſponds in ſhape with the head or condyle of the jaw, and with the hollow of the temporal bone. It moves with every motion of the jaw, facilitates the common motions, and prevents luxation; but the joint is ſtill more ſtrongly ſecured by the ſtrength of its pteregoid and temporal muſcles, which are inſerted cloſe round the joint, than by any ſtrength of its capſule. It is the muſcles which prevent luxation; and it is their action alſo that makes luxation, when it has happened, ſo difficult to reduce.

RIBS.

The ribs have two joints, and a hinge-like motion, riſing and falling alternately, as we draw in or let out the breath. The two joints of the ribs are thus ſecured: Firſt, the proper head of the ribs being hinged upon the intervertebral ſubſtance, and touching two vertebræ, it is tied to the bodies of each by a regular capſule; the bag is regular, is lubricated within, and is as perfect as any joint in the body; it is radiated without, ſo as to expand pretty broad upon the ſides of the vertebræ, and has a ſort of diviſion, as if into two faſciculi, the one belonging to the vertebra above, the other to the vertebra below: they gradually vaniſh, and mix with the

 perioſteum

perioſteum upon the bodies of the vertebræ; theſe are named LIGAMENTUM CAPITELLI COSTARUM, as belonging to the little heads of the ribs.

The back of the rib touches the fore-part of the tranſverſe proceſs, and is articulated there: conſequently there is a ſmall capſular ligament belonging to this joint alſo; but this joint is further ſecured, by two ſmall ligaments, which come from the tranſverſe proceſs of the vertebra, and take hold on the neck of the rib: one ſhort ligament coming from the point of the tranſverſe proceſs, is behind the rib, and is thence named LIGAMENTUM TRANSVERSARIUM EXTERNUM; another, rather longer, comes from the inner face of the tranſverſe proceſs, goes a little round the neck of the rib, is implanted into the lower edge of the rib, and is named LIGAMENTUM TRANSVERSARIUM INTERNUM: another ſmall ligament, exactly oppoſite to this, going into the neck of the rib, upon its back part, is alſo very regular; and other ſubſidiary ligaments from different points, aſſiſt theſe or ſupply their place.

The ribs are fixed into the ſternum by their cartilages, each of which has a round head, a diſtinct ſocket, a regular capſule, and ligaments which expand upon the ſurface of the ſternum, much in the ſame way that the ligamenta capitelli expand upon the bodies of the vertebræ: a tendinous membrane, alſo binds the cartilages of the ribs, one to another, croſſes over the interſtice, and ſo covers the intercoſtal muſcles with a ſort of faſcia; and the whole ſurface of the ſternum and that of he cartilages is covered with this tendinous expanſion, which belongs confuſedly, to the origins of the pectoral muſcles, to the ligaments of the ribs and ſternum, and to the perioſteum of that bone.

CHAP.

CHAP. II.

JOINTS OF THE SHOULDER, ARM, AND HAND.

CLAVICLE.

THE joining of the clavicle with the ſternum, is the hinge upon which the whole arm moves, and is the only point by which the arm is connected with the trunk; the round button-like head of the clavicle, rolls upon the articulating ſurface of the upper bone of the ſternum: it is in ſuch continual motion, that ſome particular proviſion is required; and accordingly, it has, like the condyle of the jaw, a ſmall moving cartilage, which rolls betwixt this head, and the ſternum. The cartilage is thin, and of a mucous nature; it is moveable in ſome degree, yet it is fixed by one edge to the head of the clavicle. This joint is encloſed in a ſtrong capſule, conſiſting firſt of a bag, and then of an outer order of fibres, which go out in a radiated form, upon the ſurface of the ſternum, like the ligaments of the ribs; and they croſs and cover the ſternum, ſo that the ligaments of the oppoſite ſides meet; and this meeting forms a cord acroſs the upper part of the ſternum, which is named INTERCLAVICULAR LIGAMENT. Thus is the clavicle fixed to the ſternum, and another broad ligament alſo ties it to the firſt rib.

The joining of the clavicle with the ſcapula, is by the edge of the flat clavicle touching the edge of the acromion proceſſes with a narrow, but flat articulating ſurface: both ſurfaces, viz. of the acromion, and of the clavicle, are covered with a thin articulating cartilage: in ſome ſubjects a moveable cartilage is alſo found here: it is a regular joint, and is very ſeldom obliterated; yet its motion, though continual, is not very free; it is rather a ſhuffling and bending of the ſcapula upon this bone, favouring the play of the other joints: it is ſecured firſt by a capſular ligament, which is in itſelf delicate and thin, but which is ſtrengthened by many liga-

ligamentous bands, which pass (over the capsule) betwixt the clavicle and the acromion process; the clavicle, as it passes over the point of the coracoid process, is tied down to it by ligaments of considerable strength; one comes from the root of the coracoid process to the clavicle, and is called LIGAMENTUM COMMUNE CONOIDES; another from the point of the coracoid process, is implanted into the lower or inner edge of the clavicle, and is named LIGAMENTUM COMMUNE TRAPEZOIDES; trapezoid, on account of its square form, and commune, because it goes from the scapula to the clavicle; while other ligaments, going from one process of the scapula to another, are named proper or peculiar ligaments of the scapula. The LIGAMENTUM PROPRIUM TRIANGULARE stretches from the coracoid process to the acromion process of the scapula. The LIGAMENTUM SCAPULÆ PROPRIUM POSTERIUS is of less importance, being that which completes the notch of the scapula into a hole, and gives attachment to the omo-hyoideus muscle.

SHOULDER JOINT.

THE SHOULDER is one of the most beautiful joints, loose and moveable, very free in its motions, but very liable to be displaced. To form this joint, the humerus has a large round and flattened head; the cavity of the scapula *, which receives this head, is oval, or triangular, small and very shallow; it is eked out with a thick cartilaginous border, which encreases the hollow of the socket, but still it is so shallow, that the humerus cannot be so much said, to be lodged in the glenoid cavity, as to be laid upon it. Its capsule or bag is very loose and wide, coming from the edges of the glenoid cavity, and implanted round the neck of the bone: the joint is richly bedewed with mucus, or rather with a mixed secretion, which is partly secreted by a fimbriated organ, consisting of lacunæ or bags, the common organ

* It is called glenoid cavity, from the Greek name of a joint, and the name is not absolutely appropriated to the scapula.

for

for this ſecretion through all the joints, and by a thinner exudation from thoſe extreme arteries, which terminate, with open mouths, upon the internal ſurface of the bag.

By the ſhallowneſs of its ſocket, and the largeneſs of its head, by the looſeneſs of its capſule, by all the forms and circumſtances of its ſtructure, the ſhoulder is exceedingly looſe, and very liable to be diſplaced: it has this looſe ſtructure, and ſuperficial ſocket, that its motions may be free, but ſeldom is there any great advantage gained in the human body, without a counterbalance of weakneſs and danger; and every where in the limbs, we obſerve that a joint is weak and liable to luxation, in proportion as its motions are free and large. Yet the ſhoulder joint is not without ſome kind of defence; its ſocket is ſhallow, but it is guarded by the largeſt projecting proceſſes in all the body, by the acromion projecting and ſtrengthening it above, and by the coracoid proceſs within; its ligament is lax, eaſily torn, and uſeful rather for confining the ſynovia, and keeping the head of the ſhoulder bone oppoſite to its proper cavity, than in ſecuring the joint by any ſtrength it has; therefore a ligament extends from the coracoid to the acromion proceſs (LIGAMENTUM PROPRIUM TRIANGULARE SCAPULÆ) which completes the defences of the joint above, and at its inner ſide. The capſule is perforated by the long tendon of the biceps muſcle, and the hole by which it enters is called *foramen ovale*, and on each ſide of this hole the ligament is much ſtrengthened; and there comes alſo from the point of the acromion proceſs, an additional ligament, which adheres to the capſule: But the circumſtance from which the chief ſtrength of the ſhoulder joint is derived, is the inſertion of the four muſcles which come from the ſhoulder blade cloſe round the head of the bone, ſo that they adhere to the capſular ligament, pull it up to prevent its being checked in the motions of the joint, ſtrengthen it by their thickneſs, for they are ſpread upon it: and the contraction of the muſcles hold the humerus in its place; their total relaxation (as in certain caſes of weakneſs)

nefs) fuffers the humerus to drop away from the fcapula, without any fall or accident, forming what we are accuftomed to call a luxation of the humerus, from an internal caufe; and the fhoulder cannot be luxated by a fall, without fuch violence as tears up the tendons of thefe mufcles. We muft add to this anatomy of the joint, that it is furrounded by numbers of burfæ or mucous bags *: one under the tendons of the fubfcapularis; one under the fhort head of the biceps mufcles; one betwixt the coracoid procefs, and the fhoulder bone; and one under the acromion procefs of the fcapula, exceedingly large: and thefe are fo fairly parts of the joint, that very commonly they open into it with communications, either perfectly natural, or at leaft, not hurtful, either originally exifting, or formed by continual friction. It fhould alfo be remembered, that the long tendinous head of the biceps mufcle comes from the margin of the focket, directly over the ball of the os humeri, and through the capfule, by a particular hole.

ELBOW.

THE ELBOW JOINT is formed by three bones; the humerus, radius, and ulna: The ulna bends backwards and forwards upon the fhoulder bone; the radius bends upon the fhoulder bone along with the ulna; it always muft accompany the ulna, but it alfo has a motion of its own, rolling in circles; its round button-like head rolling continually with its edge upon a focket in the ulna, and with its flat face upon the tubercle of the humerus. The whole compofes one joint, and is enclofed in one capfule; the bones accompany each other in their luxations, as well as in their natural motions: the ulna is never diflocated without the radius being alfo difplaced;

* Vide Monro's tables of the burfæ mucofæ, where all thefe parts are reprefented, the knowledge of which is fo very ufeful for the furgeon. I have opened this great burfa under the acromion procefs, and let out four pounds of the peculiar mucus and gelatinous lumps, with which the difeafed burfæ are commonly filled.

a circumftance

a circumſtance which is but too little noticed, and, ſo far as I remember, hardly conſidered or known.

The radius and ulna are united principally by the INTEROSSEOUS LIGAMENT, which, as it extends in the whole length of the bones, has great ſtrength. Towards the elbow this ligament is deficient for a ſpace, and it is perforated by veſſels. The CHORDA TRANSVERSALIS CUBITI is an oblique ſlip of ligament which paſſes from the tubercle of the ulna obliquely downwards and acroſs to the radius.

LIGAMENTS OF THE ELBOW JOINT.

The general CAPSULE ariſes from the humerus, from both the tubercles, and all round the two hollows which receive the olecranon and coronoid proceſſes of the ulna; it is implanted again into the tip of the olecranon, and all round that ſigmoid cavity which receives the lower end of the humerus, and all round the edge of the coronary proceſs. It is alſo fixed round the neck of the radius; it comprehends, in one bag, the humerus, radius, and ulna; and unites them into one joint, performing two motions, viz. flexion and extenſion by the ulna, and rolling by the radius; the joint is lubricated by mucus * and by fat, which is found chiefly about the olecranon: and that the bones may be further ſecured, additional ligaments are ſpread out upon them, which are all without the common capſule of the joint lying upon it, and ſtrengthening it at the neceſſary points.

1. There is the common capſule encloſing the whole. 2. It is the form of every hinge joint (and this is one of the pureſt) to have its capſule ſtrengthened at the ſides; and the ſides of this, the elbow joint, are ſtrengthened by two faſciculi, or ligamentous heads, which, coming from the tubercles of the humerus, ſpread a little upon the capſule, and adhere to it like part

* The oil contained in the adipoſe membrane never exudes in the living body, and cannot lubricate.

of

of its ſubſtance. One, from the outer condyle, ſpreads upon the neck of the radius, and ſends a ſtrong diviſion to be attached to the rough ſpine of the ulna, which is near the leſſer ſigmoid cavity of the ulna. This is of courſe the EXTERNAL LATERAL LIGAMENT. Another ligament from the inner condyle of the humerus, goes upon the inſide of the capſule and ſtrengthens it there: it is implanted in the prominence on the inner edge of the coronoid proceſs of the ulna, and is named the INTERNAL LATERAL LIGAMENT*. The continual rolling motion of the radius requires a peculiar ligament, and this peculiar ligament of the radius is named LIGAMENTUM CORONARIUM, or ANNULARE, becauſe it encircles the neck of the radius; ANULARE or ORBICULARE, from its hoop or ring-like form: It is a very ſtrong and narrow ſtripe or band, which ariſes from that part of the ulna where the radius rolls upon it, and ſurrounds the radius, making at leaſt two thirds of a circle; and ſo having turned over the neck of the radius, is inſerted into the oppoſite ſide of the ulna. This is commonly deſcribed as a diſtinct ligament ſurrounding the neck of the radius, and having the common capſule implanted into its upper edge; but, in truth, it is like the others, a thicker band of the common capſule, but with a diſtinction much more particular here, by the contraſt of the great thickneſs of the coronary ligament, and the extreme thinneſs of the capſule at the fore-part: for the capſule of every hinge-joint is ſtrong only at its ſides; other bands from the outer condyle, and from the coronary proceſs of the ulna, ſtrengthen this ligament of the radius, and are known by the general name of ACCESSORY LIGAMENTS of the coronoid ligament, as the

* I ſee another ligament behind the internal lateral ligament, viz. ariſing from the external condyle, and inſerted into the ſide of the olecranon. There are in truth two internal lateral ligaments, and their operation is not merely to confine the motion of the joint laterally, but to check the flexion and extenſion of the arm; the one being made tenſe by the flexion, the other by the extenſion, of the fore-arm.

lateral

lateral ones are known by the name of ACCESSORY LIGAMENTS to the capſule *.

So that there is, 1. A complete capſule which encloſes all the bones; 2. Lateral ligaments which make the main ſtrength of the joint; 3. A coronary ligament which regulates and ſtrengthens the rolling motions of the radius, and keeps it firm, turning like a ſpindle in its buſh. The whole joint is ſurrounded with cellular ſubſtance; the regularity of its ligaments is confounded by the adheſions of muſcles and tendons: though it is, on the whole, weak behind and before, and very ſtrong at its ſides, yet tendinous and ligamentous fibres croſs it in all directions; ſo that the capſule, and its aſſiſting ligaments, are irregular and rough without; but gelatinous, ſmooth, and gloſſy within.

WRIST.

THE WRIST is one of the moſt moveable joints in the body, having the ſtrength of a mere hinge-joint (becauſe it is almoſt a ſtrict hinge, by the connection of the long ball of the carpus with the long hollow of the radius); and having, at the ſame time, all the properties of the moſt moveable joint, by the free turning of the radius, without the weakneſs which is peculiar to the circular and free moving joints. Theſe diſtinctions divide the wriſt joint into its two parts.

1. The articulation formed by the ſcaphoid and lunated bones, which form an oval ball of articulation, and the great ſcaphoid cavity of the radius which receives this ball: the end of the ulna does not properly enter into the cavity of the wriſt, but its end, or little round head, is covered with a moveable cartilage, and that car-

* But the capſule ought to be called membrana capſularis; it is not a ligament, and theſe which are called acceſſory are proper ligaments. The ligament which is on the fore-part of the joint, and which runs towards the *Ligamentum Annulare*, is properly called *Acceſſorium Annuli Anticum*; it croſſes from the ulna to the external condyle; and another coming round from the olecranon, and being on the back of the joint, *Acceſſorium Annulare Poſticum*.

tilage

tilage represents the end of the ulna. It is called CARTILAGO INTERMEDIA TRIANGULARIS. Now, this first joint, viz. of the scaphoid and lunated bones, the head of the radius, and the moveable cartilage which represents the head of the ulna, are surrounded by the general capsule or bag of the joint. The capsule arises from the ends of the radius and of the ulna; from the styloid point of the one, round to the same point of the other; and is implanted near the lower rank of the carpal bones; though it adheres first to the scaphoid and lunated bones, it passes them going over all the bones of the carpus, especially in the palm, so as to add strength to their peculiar ligaments; and in the palm, the tendons for the fingers run over it: so it forms on one side an additional ligament for the carpus; on the other, it forms the floor of the tendinous sheath, a smooth and lubricated surface for the tendons to run upon. This general ligament is strengthened by particular ones coming from the styloid processes of the radius and of the ulna, which spread upon the bones of the carpus, and may be described as lateral ligaments, for although the wrist joint is not accurately a hinge, yet it partakes most of that character, and the ligaments are strongest at the radial and ulnar edges of the wrist. But there are so many irregular points of bone about the wrist, that the little fasciculi, with which this capsule is covered and strengthened, are innumerable. Within this joint, and stretching from the groove betwixt the scaphoid and lunated bones, there is an internal ligament of a soft and pulpy nature; it is named LIGAMENTUM MUSCOSUM; but the very name shows, that it is less valuable as a ligament (since the joint is already well enough secured), than as a conductor for the lacunæ or ducts which separate the mucus.

2. The articulation by which the hand performs all its turning motions is that of the radius with the ulna: this is set apart altogether from the general articulation of the joint. The lateral cavity of the radius receives the little round head of the ulna; they are enclosed in their own peculiar capsule, which is so loose about the bones,

bones, that although it is a regular capſule of the common form, it has the name of MEMBRANA CAPSULARIS SACCIFORMIS. Thus there is one joint within another; a moveable cartilage betwixt them, and the capſule of the one, the more moveable joint, peculiarly wide, and not ſo ſtrong; all which ſhould be conſidered in thinking about luxations of the wriſt.

The carpal bones are connected with each other ſo very cloſely, that the name of joint can hardly be uſed. They are rather fixed than jointed together. Each bone has four ſmooth articulating ſurfaces, by which it is united to the adjoining bones. The firſt two bones form the great ball of the wriſt; the ſecond row again is united with the firſt, by a ſort of ball and ſocket; for the os magnum, which is the central bone of the ſecond row, has a large round head, which is received into the lunated hollow of the os lunare, which is the central bone of the firſt row. The firſt row is thus united to the ſecond, by a diſtinct and general capſule, in addition to which each ſingle bone is tied to the next adjoining, by a regular capſular ligament within, and by flat croſs ligaments without, or rather by many bundles of ligaments, which croſs each other in a very complicated manner, and the little flat and ſhining faſciculi give the whole a radiated, or ſtar-like form *.

The metacarpal bones are alſo joined to the carpal in one row, by a line of joints, which are as one joint; beſides their common capſule, the metacarpal of each finger has its peculiar ligaments proceeding in a radiated or ſtar-like form from the carpal bones, and going out broad upon the metacarpal bones, and ſo numerous, that each metacarpal bone is ſecurely tied by ligaments to one or two of the bones of the carpus †; and at their heads

* Theſe are the ligaments which are really ſo unimportant to the anatomiſt, or to the ſurgeon, but which are ſo laboriouſly deſcribed under the titles of LIGAMENTA BREVIA, OBLIQUA TRANSVERSARIA, and PROPRIA oſſium carpi; for they do in fact croſs and tranſverſe the carpus in every poſſible direction.

† And theſe alſo are named according to their ſeveral directions, LIGAMENTA ARTICULARIA, LATERALIA, RECTA PERPENDICULARIA, &c.

 where

where the figures are implanted upon them, forming the knuckles, they are again tied by flat ligaments, which go from head to head of the metacarpal bones *, binding them together, permitting a flight bending towards each other, fo as to make a hollow in the hand, but no fuch wide motion as might affift the fingers; they are but as a foundation upon which the fingers ftand and move.

FINGERS.

The joints of the fingers are formed by round heads in the upper end of one row of bones, and by hollow fockets on the lower ends of the next row; each joint is qualified by the round form of its heads, to be a circular and free moving joint; but it is reftricted by the forms of its ligaments, to the nature of a hinge-joint; for each finger joint is included firft in a fair round capfule, or bag, of the ordinary form, but that capfule is ftrengthened by very diftinct lateral ligaments upon its fides, which lateral ligaments form the chief ftrength of the joints; above thefe lateral ligaments the joint is ftrengthened by a broad fafcia, or fheath, which comes from the tendons of the interoffei mufcles, covers the backs of all the fingers, which is efpecially ftrong over the joints. One part of the apparatus of the wrift joint is the fmooth and lubricated SHEATH, in which the tendons of the fingers run. It is formed in part by the outer fide of the capfule of the wrift, and in part by that bridge of ligament which proceeds from the four corner points of the carpal bones. This fheath is lined with a delicate and fofter modification of the common tendinous membrane, is fully bedewed with mucus, and is fairly to be ranked with the burfæ mucofæ, as it is indeed, like them, a fhut fack. But it is farther croffed in fuch a manner by partitions belonging to each flexor tendon, that each of them may be faid to have its appropriated burfa mucofa. And thefe burfæ, to prevent the bad confequences of friction, are put both betwixt

* Thefe are named the LIGAMENTA INTEROSSEA.

the crofs ligament and the tendons, and alfo betwixt the tendons of the uppermoft mufcle, and of the deeper one, and again betwixt the tendons of the fingers and of the thumb.

In the fame way the fheaths of the tendons, as they run along the fingers, may be confidered as part of the apparatus of their joints; for the firft fet of burfæ, viz. thofe which lie in the palm of the hand, ftop before they reach the firft joints of the fingers, and then other longitudinal burfæ begin from the firft joint of the fingers, and go all along them to the laft joint, forming a fheath for the tendons to run in, which does at once the office of a ftrong ligament, binding them down in their places, and which is fo lubricated on its internal furface, as to fave the neceffity of other burfæ. Thefe fheaths are thicker in certain points, fo as to form crofs rings of ftrong ligament; but the common fheath, and thefe thicker rings, ftill form one continued canal; thefe are named the SHEATHS and ANNULAR LIGAMENTS, or CROSS LIGAMENTS * of the fingers, and are of the fame nature with the burfæ. Befides thefe, there are no diftinct burfæ on the fingers, but there are feveral about the wrift, and one efpecially of confiderable fize at the root of the thumb †.

CHAP. III.

JOINTS OF THE THIGH, LEG, AND ANCLE.

OF THE HIP JOINT.

THE acetabulum, which is rough in the naked bone, is naturally lined with a thick and very fmooth cartilage. The head of the thigh bone is covered with a fimilar cartilage, alfo very thick and fmooth; and thefe

* LIGAMENTA VAGINALIA, LIGAMENTA CRUCIATA, PHALANGUM, &c.

† Vide Monro's Burfæ Mucofæ.

 cartilages

cartilages almoſt fill up that deep dimple which is ſeen in the centre of the head of the thigh-bone, and ſmooth that hole which is formed in the centre of the ſocket, by the meeting of the ſeveral pieces of which it is compoſed. The ſocket is not only deep in its bones, but is further deepened by the cartilage which tips the edge of the ſocket, and which ſtands up to a conſiderable height. The ſocket is imperfect at that ſide which looks towards the thyroid hole; the bony edge is entirely awanting there, and the ſpace is filled up by a ſtrong cartilaginous ligament, which goes acroſs this gap, from the one point to the other, and from its going acroſs is named the LIGAMENTUM LABRI CARTILAGINÆI TRANSVERSALE*. The capſular ligament of the hip joint is the thickeſt and ſtrongeſt of all the body. It is, like other capſules, a reflection and thickening of the perioſteum; the perioſteum coming along the outſide of the bone, leaves it at the edge of the ſocket. The perioſteum, or rather perichondrium from the inſide of the ſocket, comes up to the edge, and meets the outer layer. They unite together, ſo as to form the general capſule encloſing the ring-like cartilage, which tips the edge of the ſocket between them. This ligament encloſes all the bones from the edges of the ſocket to the roots of the trochanters, embracing not only the head, but the neck of the thigh bone. The outer plate, continuous with the perioſteum, is thick and ſtrong, and is aſſiſted by much cellular ſubſtance condenſed round it, and it is further thickened by ſlips which come from the iliacus, glutæus, and other muſcles which paſs over the joint, while the external plate of the ligament lines the whole with a ſoft and well lubricated coat.

In addition to this general capſule, there are two internal ligaments, 1ſt, The round ligament, as it is called, which comes from the centre of the ſocket to be fixed into the centre of the ball of the thigh-bone. It is not

* This ligament is double, that is, there is one on the inſide of the edge, and one on the outſide; thence it is often reckoned as two ligaments, viz. LIGAMENTUM TRANSVERSALE INTERNUM et EXTERNUM.

round, but flat or triangular. It has a broad triangular basis, rooted in the socket exactly at that place where the several bones of the socket meet, forming a triangular ridge, which gives this triangular form to the central ligament. It has three angles, and three flat sides. It is broad where it arises from the bottom of the socket, is about an inch and a half in length, grows narrower as it goes outwards towards the head of the bone, and is almost round where it is implanted into the dimple in the head of the thigh-bone, at which point it is so fixed, as to leave a very remarkable roughness in the naked bone. But round the roots of this ligament, and in the bottom of the socket, there is left a pretty deep hollow, which is said to be filled up with the synovial gland. It is wonderful how easily authors talk of the synovial gland, as if they had seen it; they describe very formally its affections and diseases, as when hurt by a blow upon the trochanter; yet there is no distinct gland to be found. There is a fringed and ragged mass lodged in the bottom of the socket, hanging out into the hollow, and continually rubbed by the ball of the thigh-bone in its motions: the fringes and points certainly are ducts from which we can squeeze out mucus; but it is by no means proved that they belong to a synovial gland, and it looks rather as if the ducts were themselves the secreting organ, like the lacunæ, or mucous bags in the tongue, or in the urethra, vagina, œsophagus, and other hollow tubes. Such a structure is fitter for suffering the strong pressure, and continual action of the thigh-bone, than any determined gland. We see then nothing but mucous ducts of a fringed form, hanging down from this hollow into the cavity of the joint, a quantity of fat accompanying these fringes, and a pappy mucous membrane, which keeps these fringes and fatty membranes orderly, and in their places, and which ties them so to the angles of the triangular ligament, that they must move with the motions of the joint. This mucous membrane, which keeps these fatty fringes orderly, has two or three small bridles in different directions, whence they are named the LIGAMENTA MUCOSA, or ligamentula massæ adiposæ glandulosa;

losa; and this may be considered as the continued inflection of the softer internal lamella of the capsule, which not only lines the socket, but is reflected over the central ligament, and over the globe of the thigh-bone, covering them also with a delicate mucous coat. Other fringes of the same kind are found at the lower part of the joint, lying round the neck of the thigh-bone, near the angle where the capsular ligament is implanted into the root of the great trochanter: the liquor from these mucous fimbriæ, with the general serous exudations, are mixed and blended for lubricating the joint.

This capsule, which is naturally the thickest and strongest in the body, almost a quarter of an inch in thickness, is farther strengthened by many additions; for a slip of very strong tendinous, or cellular substance condensed, comes down from the lower spinous process of the os ilium, and spreads out over the capsule, and strengthens it very much on its fore-part; the smallest of the glutæi muscles adheres to the capsule, and strengthens it behind; the psoas magnus and iliacus internus pass by the inner side of the capsule, and though they do not absolutely adhere to it, they deposit much cellular substance, which is condensed so as to strengthen the capsule, forming at the same time a large bursa mucosa, betwixt their tendinous fibres and the joint. That tendon of the rectus muscle which comes from the margin of the socket, lies upon the outer side of the capsule, adheres to it, and strengthens it. The security of the hip-joint seems to depend more upon the strength of its capsular ligament, than that of almost any other joint.

THE KNEE-JOINT.

The knee-joint is one of the most superficial joints, and one of the weakest, so far as relates to the bones, for the flat condyles of the thigh-bone are merely laid upon the flat head of the tibia. There is here no fair cavity, receiving a large head, as in the joint of the hip; no slighter ball and socket, as in the fingers; no strong overhanging bones, as in the shoulder; no hook-like process,

cefs, as in the ulna. This is not a hinge-joint, like the ancle, fecured between two points of bone. We do not find the means of ftrength in its bones, but in the number, fize, and difpofition of the great ligaments with which its bones are joined; by virtue of thefe ligaments it is the ftrongeft joint of the human body, the moft oppreffed by great loads, the moft exercifed in continual motions, yet lefs frequently difplaced than any other. But this complication of ligaments which gives it mechanical ftrength, is the very caufe of its conftitutional weaknefs, makes it very delicate, and very liable to difeafe.

The bones which compofe this joint are the tibia, thigh-bones, and patella; and they are united by many ligaments, both within and without the joint.

1ft, The CAPSULE of the KNEE is naturally very thin and delicate, tranfparent as a cobweb. This thin capfule comes from the fore-part of the thigh-bone, all round the articulating furfaces, whence it goes downwards by the fides of the condyles; from this origin it is inferted into all the edge of the rotula, and in fuch a way as to keep the rotula properly without the cavity of the joint, the capfular ligament going over its inner furface, and lining it with a fmooth and delicate coat. It is fixed below into all the circle of the head of the tibia, and thus completes its circle, embracing all the bones. This capfule, naturally fo thin and delicate, is made up from all the furrounding parts to a confiderable thicknefs; firft, it is covered behind by the heads of the gaftrocnemii; at the fides, by the biceps, and other mufcles of the hamftrings; on its fore-part, it is ftrengthened by the general fafcia of the thigh, which goes down over the knee, and being there reinforced both by its adhefion to the bones, and by the broad expanfion of the vaftus internus, fartorius, biceps, and other mufcles, which go out over the patella, it adheres to the capfule, and makes the whole very ftrong; befides which, there is a ligament, which, lying in the ham, upon the back part of the capfule, is named, in compliment to Winflow, LIGAMENTUM POSTICUM WINSLOWII. It is a ligament fomewhat refembling the

 lateral

lateral ligaments of the elbow. It ariſes from the outer condyle, goes obliquely acroſs the back part of the joint, adheres to it, and ſtrengthens it; but often it is not found at all, or in ſuch ſtraggling fibres as cannot be accounted a ligament *. It is manifeſt that the knee requires ſome ſuch additional ligaments behind, to ſerve as a check, and to prevent its yielding too far.

2. The knee, as being a hinge-joint, has ſtrong ligaments at the ſides, and here the lateral ligaments are particularly diſtinct, and can be raiſed from the capſule; on the inner ſide of the joint, there comes down from the internal condyle of the thigh-bone, a broad, flat ligament, which is fixed into the inner head of the tibia, and is named the internal lateral ligament; on the outſide of the knee, there deſcends from the tip of the outer condyle a much ſtronger ligament, not quite ſo flat, rather round: It extends from the condyle of the thigh-bone, to the bump of the fibula which it embraces. It is a little conical from above downwards; it is from two to three inches in length, and is named LIGAMENTUM LATERALE EXTERNUM LONGIOR, to diſtinguiſh it from the next; for behind this firſt external ligament, there ariſes a little lower from the ſame condyle along the outer head of the gaſtrocnemius muſcle a ligament which is called the LIGAMENTUM LATERALE EXTERNUM BREVIOR, and it is not ſhorter only, but ſo ſparce as not to be eaſily diſtinguiſhed, not having the true form of a lateral ligament coming down from the condyle, but of a mere ſtrengthening of the capſule, coming upwards from the knob of the fibula †.

3. The joint is ſtill further ſecured by internal ligaments which are within the cavity of the joint; they are named the CRUCIAL LIGAMENTS of the knee. They ariſe betwixt the hollow of the condyles of the thigh-bone, and are implanted into the back part of the middle riſing of the tibia: they lie in the back part of the joint,

* Often it is irregular, or in ſtraggling fibres; but I have never found it wanting.

† Some ſtrong, but irregular acceſſary ligaments go down to that part of the head of the tibia which is before the head of the fibula.

flat upon the back of the capſule, and the one croſſing a little before the other (but yet in contact with each other, at the place of croſſing); they are diſtinguiſhed by the names of ANTERIOR and POSTERIOR CRUCIAL LIGAMENTS.

The POSTERIOR CRUCIAL ligament is more perpendicular; it ariſes from the hollow betwixt the condyles of the thigh-bone, and is implanted into a roughneſs on the back of the tibia, betwixt its two cup-like hollows, and behind the tubercle which divides theſe hollows from each other. While the poſterior ariſes rather from the internal condyle, the ANTERIOR LIGAMENT ariſes properly from the external condyle, paſſes obliquely over the tuber, in the articulating ſurface of the tibia, and terminates in the cup-like hollow. The effect of theſe two ligaments is more particular than is commonly obſerved; for the one goes obliquely out over the articulating ſurface of the tibia, while the other goes directly down behind the joint; and of courſe when the knee is bended, the poſterior ligament is extended; when the leg is ſtretched out, the anterior ligament is extended; they both are checks upon the motions of the joint: the anterior ligament prevents the leg going too far forwards, the poſterior ligament prevents it being too much bent back upon the thigh *.

4. The moſt admirable part of the mechaniſm of this joint, is the two SEMILUNAR CARTILAGES. They are ſo named from their ſemilunar form; they lie upon the top of the tibia, ſo as to fill up each of them one of the hollows on the top of that bone. They are thicker towards their convex edges, thinner towards their concave edges; they end by two very acute and long horns,

* There is not attention enough paid to the origins of theſe ligaments from the femur; for it is the origin from the thigh-bone which determines their operation. The poſterior ligament comes from the root of the internal condyle, and depth of the ſemilunar noch, anterior to the centre of motion of the lower head of the femur on the tibia; it is conſequently ſtretched in extending the leg. The anterior ligament ariſes from the root of the external condyle, poſterior to the centre of motion; it is conſequently ſtretched in the flexion of the knee-joint.

named

named the CORNUA of the lunated cartilages. In ſhort, they reſemble the ſhape of the label which we put round a wine decanter; and the two horns are tied to the tubercle, or ridge that ſtands in the middle of the articular ſurface of the tibia, and conſequently they are turned towards each other, ſo as to touch in their points. There are here, as in the other joints, maſſes of fat encloſing the fimbriated ends of the mucous ducts. Theſe fimbriæ, and fatty bundles, are formed chiefly round the circumference of the patella, commonly ſurrounding it with a complete fringe; they are alſo found at the back of the cavity, about the crucial ligaments, and in all the interſtices of the joint; the fatty bundles filling up the interſtices, protecting the mucous ducts from more violence than what is juſt neceſſary to empty them, and perhaps mixing their exudation with the mucus of the ducts.

Theſe maſſes of fat lie covered by the delicate internal ſurface of the capſule, and the mucous fimbriæ project from it.

The inner ſurface of the capſule is ſo much larger than the joint which it lines, that it makes many folds or lurks, and ſeveral of theſe are diſtinguiſhed by particular names. Thus, at each ſide of the patella there are two ſuch folds, the one larger than the other, whence they are named LIGAMENTUM ALARE MAJUS, and LIGAMENTUM ALARE MINUS. Theſe two folds are like two legs, which join and form one middle fold, which runs acroſs in the very centre of the joint, viz. from the lower end of the patella to the point of the thigh-bone, in the middle betwixt the condyles. It keeps the looſer fatty bundles and fimbriated ducts in their place (viz. the hollow betwixt the condyles, where they are leaſt expoſed to harm); thence it has been long named the LIGAMENTUM MUCOSUM. The internal membrane of the joint covers alſo the ſemilunar ligaments, as a perichondrium; it comes off from the ridge of the tibia, touches the horns of the ſemilunar cartilages, moves over the cartilage, ſo as to give them their coat, and at the point where it firſt touches the horns, it forms four little

little ligaments, two for the horns of each cartilage. These tags by which the four points of the lunated cartilages are tied, are named the LIGAMENTA CARTILAGINUM LUNATARUM, or more simply named the four adhesions of the lunated cartilages. There is a little slip of ligament, which goes round upon the fore-part of the knob of the tibia, and ties the fore-parts of these two cartilages to each other. It is named LIGAMENTUM TRANSVERSALE COMMUNE, because it goes across from the fore-edge of the one cartilage to the fore-edge of the other, and because it belongs equally to each; but for their further security, these cartilages also adhere to their outer circle, or thick edge, to the internal surface of the general capsule of the joint, and that again adheres to the lateral ligaments which are without it; so that there is every security for these cartilages being firm enough in their places, to bear the motions of the joint, and yet loose enough to follow them easily.

This joint has the largest bursæ mucosæ of all, and these perhaps the most frequently diseased. There is one bursa above the patella, betwixt the common tendon of the extensor muscles and the fore-part of the thigh-bone, which is no less than three inches in length. There is a smaller bursa about an inch below the patella, and under the ligament of the patella, protecting it from friction, upon the head of the tibia. These bursæ, I am persuaded, are often the seat of disease, when it is judged to be in the joint itself. But the truth is very easily known; for if a swelling appear under the patella, projecting at the sides, and raising the patella from the other bones, we are sure that it must be in the main cavity of the joint: but if swellings appear above and below the patella, then there is reason to believe that these belong to the great bursæ, which are placed above and below the patella, a complaint which is far less formidable than a swelling of the joint itself: I would almost say, easily cured; for openings into these bursæ, though they should be avoided, are less dangerous than openings into the joint. It is from mistaking such tumours for collections in the capsule itself, that authors speak of openings into the

the joint as a familiar or eafy thing, or think that they have done fuch operations fafely, when probably they were puncturing the burfæ only *.

Thefe burfæ mucofæ lie under the tendon of the extenfor mufcles, and under the ligament of the patella: they are of the fame fubftance with the capfule of the joint itfelf; they lie over the capfule, united to it by cellular fubftance, and the bundles of fat which are difpofed irregularly about the joint, belong partly to the burfæ, and partly to the capfule; one end projecting into the cavity of the burfæ, while the other end of the fame fatty bundles projects into the cavity of the joint.

Thus the knee-joint, which is the moft important in all the body; the moft oppreffed by the weight of the trunk, and by the accidental loads which we carry; the moft exercifed in the common motions of the body; and the moft liable to fhocks and blows, which is the moft fuperficial and the weakeft in all that refpects its bones, is the ftrongeft in its ligaments, and the moft perfect in all the provifions for eafy motion.

1. The great CAPSULE of the joint enclofes the heads of the bone, fecretes (in part) and contains the fynovia; lines the joint with a fmooth and delicate membrane, and, by turning over all the parts, and adhering to them, it forms the perichondrium for the cartilaginous heads of the bones, and the covering and ligaments for the moving cartilages of the joint.

2. This capfule, which is exquifitely thin, and which was formed for other ufes than for giving ftrength to the joint, is furrounded on all fides with fuch continuations of the common fafcia, and fuch particular expanfions of the ham-ftring and other mufcles, as by adding outwardly fucceffive layers to the capfule, brings it to a confiderable degree of ftrength.

3. The capfule having no ftrefs upon its fore-part, is very thin upon its fore-part, viz. at the fides of the patella, but is ftrengthened at the fides by fair and diftinct

* I believe that the great burfæ and the joint always communicate largely; and that being confequently one continuous furface, the opening of the burfæ would be highly improper.

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ligaments, going from point to point of the three great bones, and ſo large and particular, as to deſerve, more than any others in the body, the name of LATERAL LIGAMENTS; at the back part of the joint, the ſame ſtrength is not required as at the ſides; yet it muſt be ſtronger than at its fore-part, wherefore it is ſtrengthened by the additional bands which are ſometimes general and confuſed, but often ſo perfect and diſtinct, as to be known by the name of the POSTERIOR LIGAMENT of WINSLOW; and as the lateral ligaments prevent all lateral motions, this ſtrengthening of the capſule ſerves as a check band behind.

4. It is only in the greateſt joints that we find the additional ſecurity of INTERNAL LIGAMENTS, and the only joints where they are perfect, are the joints of the hip and of the knee; the former having its round, or rather triangular ligament which ſecures the great ball of the thigh-bone, and fixes it in its place; the latter having its crucial ligaments, which, coming both from one point nearly, and going the one over the face of the tibia, and the other down the back of that bone, ſerve the double purpoſe of binding the bones firmly together, and of checking the larger and dangerous motions of the joint, the fore ligament preventing it going too far forwards, and the back ligament preventing it bending too much.

5. A MOVING CARTILAGE for facilitating motion and leſſening friction, is not common, but is peculiar to thoſe joints whoſe motions are very frequent, or which move under a greater weight; ſuch are the inner head of the clavicle, the articulation of the jaw, and the joints of the wriſt and of the knee; and it is in the knee that the moveable cartilages have their moſt perfect forms and uſe, are large and flat ſemilunar, to correſpond with the forms on the head of the tibia; thicker at their outer edges to deepen the ſocket; and though moveable, yet ſo tied with ligaments, as never to go out from their right place.

And, 6. The mucous folicular bundles of fat, and the burſæ mucoſæ, which complete the lubricating apparatus

apparatus of the joint, and the mucous frenulæ or ligaments, which both conduct the mucous fringes and keep them in their place, are more perfect in the knee, and greater in number and ſize, than in any other joint.

I may well call this the moſt complicated, and (by daily and melancholy proofs) it is known to be the moſt delicate joint of the body.

FIBULA.

The FIBULA is a ſupport to the tibia in its various accidents; it gives a broader origin to the muſcles, and it is the chief defence of the ancle joint. It has no motion upon the tibia; the beſt authors ſpeak of it as a ſymphyſis, which claſſes it with the joinings of the pelvis, and excludes it from the liſt of true and moveable joints. It is united with the tibia by a ſort of flat cartilaginous ſurface upon either bone; it is merely laid upon the tibia, not ſunk into it. It is tied by a cloſe capſule: it has no particular ligament for itſelf; but is ſtrengthened by the external lateral ligament of the knee, which adheres to this knob, and by the inſertion of the biceps tendon, which is implanted into this point, and which ſpreads its expanded tendon over the fore-part of the tibia, and holds the bones together; and the firmneſs of the fibula is further ſecured by the great interoſſeous ligament, which goes from bone to bone. Towards the head of the bones the interoſſeous ligament is deficient.

ANCLE.

The ANCLE joint owes leſs of its ſtrength to ligaments than to the particular forms of its bones; for while the ſtrong lateral ligaments of the knee guard it ſo that it cannot be diſlocated till they are torn, the lower heads of the tibia and fibula ſo guard the foot, that when luxated theſe bones are often broken. Firſt, the fibula is ſo connected with the tibia, at its lower end, that they form together one cavity for receiving the aſtragulus, with

with two projecting points, the fibula forming the outer ancle, and the tibia forming the process of the inner ancle; the joining of the fibula to the tibia here, is like that of its upper end, too close to admit of the smallest motion, and it is thoroughly secured by particular ligaments, one of which passing from the fibula to the tibia on the fore-part, is named the LIGAMENTTM SUPERIUS ANTICUM, consisting, in general, of one or two distinct flat bands. Another more continued and broader ligamentous membrane goes from the fibula to the tibia across the back part, and is named LIGAMENTUM POSTICUM SUPERIUS; the LIGAMENTUM POSTICUM INFERIUS, being but a slip of the same. Next comes the capsule of the joint, which joins the astragalus to the lower heads of the tibia and fibula; it is thinner both before and behind, than we should expect from the strength of a joint which bears all the weight, and the most violent motions of the body. But, in fact, the capsule every where serves other purposes than giving strength to the joint, and never is strong, except by additional ligaments from without; so it is with the ancle joint, the capsule of which is exceedingly thin before; but it is strengthened at the back part, and especially at the sides, by supplementary ligaments: First, a strong ligament comes down from the acute point of the inner ancle, expands in a radiated form upon the general capsule; adheres to it, and strengthens it, and is fixed all along the sides of the astragalus, to the os calcis and naviculare. This ligament, coming from one point, and expanding to be inserted into a long line, has a triangular form, whence it is named LIGAMENTUM DELTOIDES; and while the general ligament secures the joint towards that side, the oblique fibres of its fore-edge prevent the foot being too much extended, as in leaping, and its oblique fibres on the back edge prevent its being too much bended, as in climbing; but the ligaments of the outer ancle, tying it to the outer side of the astragalus, are indeed distinct, one going forwards, one going backwards, and one running directly downwards; one goes from the point or knob of the fibula, obliquely

downwards

downwards and forwards, to be inserted into the side of the astragalus; it is square and flat, of considerable breadth and strength, and is called LIGAMENTUM FIBULÆ ANTERIUS. Another ligament goes perpendicularly downwards, from the acute point of the outer ancle, to spread upon the side of the astragalus, and of the capsule, and is finally inserted into the heel-bone; this is named the LIGAMENTUM FIBULÆ PERPENDICULARE: A third ligament goes out still from the same point, to go backwards over the back part of the capsule, adheres to the back of the capsule, and strengthens it, and is named LIGAMENTUM INTER FIBULAM, ET ASTRAGALUM POSTERIUS. There is nothing very particularly worth of notice in the ancle joint, for it is covered with cartilages, lined with a soft and MUCOUS membrane, and lubricated with mucous fimbriæ and masses of fat, such as are found in all the joints. It is stronger than the other joints; it can hardly be luxated, without a laceration of its ligaments, and breaking of the bones which guard it at either side; and it is the great violence which is required for completing this dislocation, and the terrible complication of dislocation, fracture, and laceration of the skin, which makes this accident so dangerous beyond any other luxation.

UNION BETWIXT THE BONES OF THE TARSUS.

The ASTRAGALUS, OS CALCIS, OS NAVICULARE, and all the bones of the tarsus, are united to each other by large heads, and have distinct and peculiar joints; besides which, the bones are cross-tied to one another by ligaments, so numerous and complicated, that they cannot nor need not be explained. They pass across from bone to bone, in an infinite variety of directions, some longitudinal, some transverse, and some oblique. There is a curious complication, which we may call a web of ligaments, covering either side of the foot with shining and star-like bundles; each bone has its capsular ligaments for joining it to the next; each joint of each bone has its articulating cartilages always fresh and lubricated;

each joint has, besides its capsule, flat strips of oblique, longitudinal, and transverse ligaments, joining it to the nearest bones, and the greater bones have larger and more important ligaments; as from the astragalus to the os calcis, from the os calcis to the os naviculare, and from that again to the scaphoid bone, &c.

The metatarsal bones have their capsular ligaments joining them to the tarsal bones, and they have ligaments strengthening their capsules, and tying them more strongly to the tarsal bones; and, as in the metacarpal bones, the several ranks are tied one to another by cross ligaments which pass from the root of one bone to the root of the next; so we have ligaments of the same description and use, holding the metatarsal bones together, both on the upper and on the lower surface of the foot; and all the ligaments of the foot are of great strength and thickness. The lower ends of the metatarsal bones have also transverse ligaments by which they are tied to each other. The toes have hinge-joints formed by capsules, and secured by lateral ligaments, as those of the fingers are; and, except in the strength or number of ligaments, the joinings of the carpus, metacarpus, and fingers, exactly resemble the joinings of the tarsus, metatarsus, and toes.

But these ligaments, though helping to join the individual bones, could not have much effect in supporting the whole arch of the foot. It is further secured by a great ligament, which extends in one triangular and flat plate, from the point of the heel to the roots of each toe. This is named the APONEUROSIS PLANTARIS PEDIS, which is not merely an aponeurosis for covering, defending, and supporting the muscles of the foot; that might have been done on easier terms with a fascia very slight, compared with this; but the chief use of the plantar aponeurosis is in supporting the arch of the foot. It passes from point to point, like the bow-string betwixt the two horns of a bow, and, after leaping, or hard walking, it is in the sole of the foot that we feel the straining and pain; so that, like the palmar aponeurosis, it supports the arch, gives origin to the short muscles of the

 toes,

toes, braces them in their action, and makes bridges under which the long tendons are allowed to pass: it comes off from the heel in one point; it grows broader in the same proportion as the sole of the foot grows broad. It is divided into three narrow heads, which make forks, and are inserted into the roots of the second, third, and fourth toes; and the great toe and the little toe have two smaller or lateral aponeurosis, which cover their own particular muscles, and are implanted into the roots of the great toe and of the little toe.

The bursæ mucosæ surround the ancle and foot in great numbers. None of them having any very direct connection with the joint, and most of them accompanying the long tendons as they pass behind the ancle, or in the sole of the foot, are of that kind which we call tendinous sheaths. First, there are sheaths of two or three inches long, which surround the tendons of the tibialis posticus, and of the peronæi muscles, as they pass down behind the ancle. The sheaths of the peronæi begin from that point where the tendons first begin to rub against the bone, and are continued quite down into the sole of the foot; making first a common sheath for both tendons, and then a bursa peculiar to the tendons of the peronæus brevis muscle, and about an inch in length. When the peronæus longus begins to pass under the sole of the foot, the sheath which enclosed it behind the ancle, is shut, and a new bursa begins; in the same manner where the tendons of the flexor policis, and flexor digitorum pedis, pass behind the inner ancle, a bursa of three inches in length surrounds them, and facilitates the motion. As the tendons of flexor muscle go under the arch of the foot, they lie among soft parts, and rub chiefly against the flesh of the massa carnea, and the belly of the short flexor muscles: But whenever they touch the first joints of their toes, they once more rub against a hard bone. New bursæ are formed for the tendons; each bursa is a distinct bag, running along the flat face of the toe, and is of a long shape, and the tendon is carried through the centre of the lubricated bag, so that we see once more, that there is no true

true diſtinction betwixt burſæ mucoſæ, and tendinous ſheaths; nor betwixt the tendinous ſheaths, and the capſules of joints.

Joints have been arranged under various forms, but not with much ſucceſs; and I do not know that enumerating the joints in any particular order will either explain the motions of individual joints, or aſſiſt in recording their various forms; ſome joints are looſe and free, capable of eaſy motions, but weak in proportion, and liable to be diſplaced; ſuch is the JOINT of the SHOULDER, which rolls in every direction; other rolling joints more limited in their motions, are better ſecured with ligaments of peculiar ſtrength; ſuch is the JOINT of the HIP, where the ligaments are of great ſtrength both within and without; ſome wanting all circular motions, are hinge joints, by the mere form of their bones; ſuch are the LOWER JAW, the VERTEBRÆ, the ELBOW, and the ANCLE JOINTS; ſome are hinges by their ligaments, which are then diſpoſed only along the ſides of the bones; ſuch are the KNEE, the RIBS, the FINGERS, and the TOES. Some joints partake of either motion, with all the freedom of a ball and ſocket-joint, yet with the ſtrength and ſecurity of the ſtricteſt hinge: Thus the WRIST having one joint by which its turning motions are performed, and another joint by which it rolls, has the two great endowments ſo rarely combined in any joint of the freeſt motion, and of great ſtrength; ſo alſo has the HEAD, by the combination of two joints of oppoſite uſes and forms; for its own condyles play like a mere hinge upon the atlas, and the axis of the dentatus ſecures all the properties of a circular joint; this combination gives it all the motions of either joint, without their peculiar defects. But there is ſtill a third order of joints, which have ſuch an obſcure and ſhuffling motion, that it cannot be obſerved. The CARPUS and METACARPUS, the TARSUS and METATARSUS, the TIBIA with the FIBULA, have theſe ſhuffling and almoſt immoveable joints; they are not intended for much motion among themſelves, but are appointed by a diffuſed and gradual yielding, to facilitate the motions of other joints.

THE

ANATOMY

OF THE

HEART AND ARTERIES.

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BOOK I.

OF THE HEART.

CHAP. I.

OF THE MECHANISM OF THE HEART.

THE heart is placed nearly in the centre of the human body, and is itſelf the centre of the circulating ſyſtem. The ſyſtem of veſſels, which it excites and moves, conſiſts of arteries and of veins;—the arteries act with great ſtrength, with a pulſation like that of the heart itſelf, and convey the blood over all the body; the veins are in greater number, exceedingly large, pellucid almoſt in their coats, incapable of that energetic action with which all the functions of the arteries are performed; they return the blood to the heart with a flow, equable, and gentle motion, and depoſite at the right ſide a quantity of blood equal to that which is at each pulſation driven out from the left. The heart is placed betwixt the arteries and the veins, to regulate and enforce their action; to receive the blood from the veins by a ſlow dilatation, and to reſtore, by a

 ſudden

ſudden contraction, that force which the blood loſes in paſſing round the circle of the body. But the heart has alſo another and more important office to perform; for by having four great cavities and two orders of arteries, it performs in the ſame inſtant two circulations, one for the lungs and one for the body; it receives from the lungs nothing but pure blood, it delivers out to the body nothing but what is fit for its uſes: and this purifying or oxydation of the blood, and this excitement of the arteries, are two chief points of modern phyſiology, which every ſtep of the following demonſtration will tend to explain.

It will be moſt eaſy to conceive at firſt the idea of a more ſimple heart, of one circle of actions, of one ſimple circulation; of one bag for receiving, and another joined to it for propelling, the blood. Indeed a heart conſiſts merely of theſe eſſential parts; a GREAT VEIN, an AURICLE, a VENTRICLE, and a GREAT ARTERY: of a vein which returns the blood from all the body; of an auricle or ſmaller bag, which receives that blood and retains it till the action of the heart is relaxed; of a ventricle (which is the proper heart), ſtrong, muſcular, very irritable, and eaſily excited, into which the auricle pours its blood; of an artery which is allied to the ventricle in ſtrength and action (as the auricle is to the vein in the delicacy of its coats), and which carries on the blood to the extremities of the body;—and the vein and artery meeting at their extremities in the body, and uniting, the whole is a circle, and the heart is the central power.

If an animal do not breathe, its ſyſtem will be what I have now deſcribed; it will have but one vein, one auricle, one ventricle, one artery; it will have one ſimple heart: but with us, and other breathing animals, it is not ſo; and I am now to deſcribe a more complex and curious circulation. For ſuppoſe this blood, ſo eſſential to our exiſtence, to have in it ſome principle of life, which is continually loſt, or in its paſſage through the body, to be impregnated with ſomething which ſhould be thrown off, that principle muſt be continually

renewed,

renewed, or an opportunity given to ſend off what is offenſive to life: the heart which fills the arterial ſyſtem, muſt not be taken from its appointed office, nor diſturbed; nature appoints a ſecond heart, which belongs entirely to this moſt important of all functions, viz. renewing the blood; and it may be renewed in many various ways. It might, for example, circulate in ſome peculiar viſcus, like the liver or ſpleen; in the fœtus it does circulate in ſuch a maſs, for the placenta is a thick and flat cake, whoſe office we know to be equivalent to that of the lungs, but whoſe ſtructure we do not underſtand: in the chick we ſee its blood circulating over the yolk (for the yolk is incloſed within the membranes of the unhatched chick), and we perceive the blood redder as it returns to the heart, and plainly changed: in fiſh we find the blood circulated over the gills, expoſed thoroughly to the water in which they ſwim, and thus the gills perform to them the function of lungs. But in all breathing creatures, the lungs do this office; the lungs are, next to the heart itſelf, eſſential to life; in thoſe who die from bleeding, we can perceive from the livor of the face, from the ſobbing and ſtruggles of the cheſt, from the regular convulſive ſighs of thoſe creatures which are butchered, rather a deſire for air than a want of blood. It is for the purpoſe of this ſecond circulation that nature has appointed in all the warm-blooded animals two hearts, a heart for the lungs, and a heart for the body; two veins, two auricles, two ventricles, and two great arteries, one the pulmonic artery, or artery of the lungs, the other the aorta, or artery of the body.

There are other varieties which diſtinguiſh animals into creatures of cold or of warm blood; for there are certain conſtitutions which do not require that the blood ſhould be thus continually renewed. It is not becauſe animals are amphibious, or go into the water, that they have peculiar lungs; for the Land Tortoiſe, the Newt, the Cameleon, never go into the water; yet they have membranous lungs: nor indeed can the amphibiæ, as the

the Seal, the Porpoiſe, the Sea-lion, &c. dive and exiſt under water more than a man can do, though for whole days they lie in herds baſking upon the ſhore: it is their peculiar conſtitution to need leſs than other creatures the office of the lungs. The cold-blooded animals are generally creeping animals, ſluggiſh, languid, cold, inert, difficultly moved, and tenacious of life to a wonderful degree. They can bear all kinds of ſtimuli; they can bear to have their heads, legs, bowels, cut away; and among other peculiarities of this conſtitution, they can live long without air: they will riſe from time to time above water, if you allow them; they can bear again to be kept under water, if you force them: but if they can live long under water, they can alſo live at leaſt as long after you have cut off their heads, or cut out their hearts.

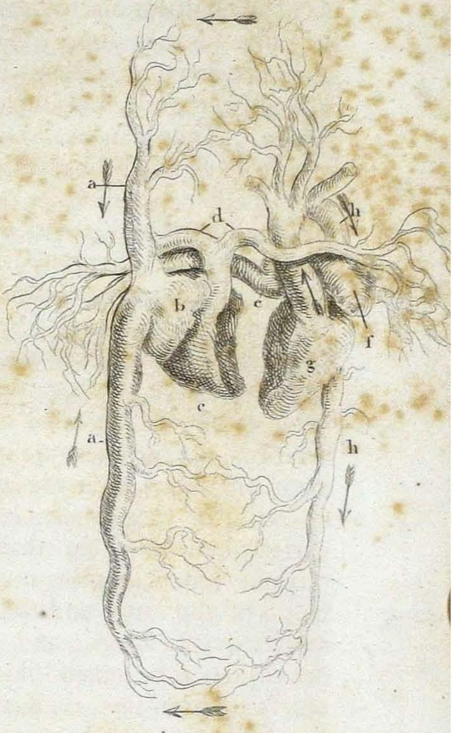
Of thoſe cold-blooded creatures always either the heart or the arteries are peculiar; the heart is ſo in many amphibiæ, as in the Turtle, where the heart ſeems to conſiſt of three ventricles, but with partitions ſo imperfect betwixt them that they are abſolutely as one: this one ventricle gives out both the great arteries; the blood of the lungs and the blood of the body are both mixed in the heart: and ſince there are two arteries conveying this mixed blood, if the two arteries be nearly equal in ſize, then it is juſt one half of the blood thrown out by the heart at each ſtroke that receives the benefit of the lungs. In many others, as the frog, the newt, the toad, the peculiarity is in the arteries alone; they have one ſingle and beautiful heart; there is one large auricle as a reſervoir for all the blood both of the body and of the lungs; there is one neat, ſmall, and very powerful ventricle placed below the reſervoir, having ſtrength quite ſufficient for moving both the blood of the lungs and the blood of the body; and this ventricle gives off an aorta, which ſoon divides into two branches, one for the body and one for the lungs; and theſe of courſe have but half the blood of this heart expoſed to the air: theſe alſo are cold-blooded animals.

But

Plans of the Heart

No 1

No 3



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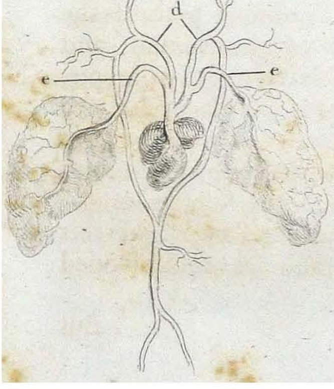

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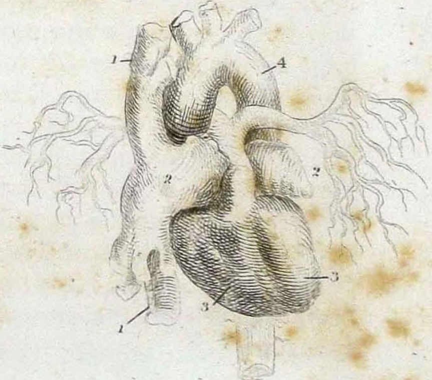


But all breathing creatures, ſuch as are called animals of hot blood, have two hearts: the one heart is ſending blood through the lungs while the other heart is puſhing its blood over the body; not the half only, but the whole blood which is ſent by each ſtroke of the heart over the body muſt have firſt paſſed through the lungs; no blood can reach the heart of the body which has not been ſent to it through the lungs; or, in other words, the veins of the lungs, and they alone, feed the left ſide of the heart.

Words alone will never explain any of the endleſs difficulties which concern the mechaniſm of the heart; but at every point, in every kind of difficulty, in explaining the form, the parts, the poſture, even the coats or coverings of the heart, I ſhall have recourſe to plans, ſuch as cannot fail to make all this intricate mechaniſm be eaſily conceived.

The moſt ſimple form of the heart, which is repreſented in the plan, No. 1. has a vein marked (*a*),—and auricle (*b*),—a ventricle (*c*),—an artery (*d*);—it has no proviſion for purifying the blood; it has no reſemblance to that kind of heart which is connected with lungs; but the blood is received by the vein, falls into the auricle, is driven by its force into the ventricle, by the ventricle it is thrown into the artery, and courſes round all the body, till at length, reaching the extremities of the veins, it paſſes by the veins to the auricle a ſecond time, and ſo this ſingle circle is perfect.

The heart of the amphibious creature is repreſented in No. 2.; it is a frog's heart: it has the moſt ſimple form, and the feweſt parts; it has the ſame vein, auricle, ventricle, and artery; but its great artery divides into two chief branches, of which (*d*)—the aorta goes to the body,—(*e*) the pulmonic artery goes to each ſide of the lungs.

The heart of a breathing creature is repreſented in No. 3. in its moſt intelligible form; and the double circulation of the human body may be traced eaſily in the following way.—Here the heart of the lungs is ſet off from the heart of the body, being as diſtinct in office

as in form and parts; on the right ſide is the heart of the lungs, on the left ſide is the heart of the body.—(*a*) Is the great vein called vena cava from its immenſe ſize;—there is an aſcending and a deſcending cava; the one brings the blood from the head and arms, the other brings the blood from all the lower parts of the body; they meet at (*a*), and form by their dilatation there, a chief part of that bag which is called the auricle,—in it they depoſite all the returning blood of the body, and thus preſent it at the right ſide of the heart to be moved through the lungs.—(*b*) Is the right ſinus, or RIGHT AURICLE; it is in part formed by a dilatation of theſe veins, but it puts on a ſtrong and muſcular nature as it approaches the heart; it is the firſt cavity of the heart, and, like all its parts, is ſtrong and irritable; it is filled by the returning blood of the cavæ; it receives, dilates, is oppreſſed by this great quantity of blood; it is ſtrongly excited to act; in its action the blood goes down into the ventricle or lower cavity of the heart.—(*c*) Is the RIGHT VENTRICLE, thick and ſtrong in its walls, and of great muſcular power; it is filled by the auricle, and is ſtrongly ſtimulated both by the ſtroke of the auricle, and by the weight and quantity, and alſo, in ſome degree, by the qualities, of the blood; its action is ſudden and violent, and it drives the blood through all the ſyſtem of the lungs.—(*d*) Is the PULMONIC ARTERY,—the artery of the lungs which receives all the blood of the right ſide of the heart; it is filled by the ſtroke of the right ventricle, from whoſe cavity it ariſes; it carries the blood in many branches through all the ſubſtance of the lungs; and thus that blood which had returned imperfect and robbed of its vital quality to the right auricle of the heart, is by this circulation through the pulmonic artery ventilated and renewed, and made fit for the uſes of the ſyſtem; and thus the leſſer circulation or the circulation of the lungs, the circulation of the right ſide of the heart, is completed, and the purified blood is brought round to the left ſide of the heart to undergo the greater circulation or the circulation of the body.

Thus

Thus it is from the extremities of this firſt circle that the ſecond circle begins; it conſiſts of like moving powers, of an auricle, ventricle, vein, and artery; for as the right heart receives the contaminated blood of the body from the veins of the body, the left heart receives the purified blood of the lungs from the veins of the lungs.—(*e*) Repreſents the VEINS OF THE LUNGS, which are ſometimes three, ſometimes four, in number; two enter from each ſide of the lungs, and return the blood purified in the lungs to the left auricle of the heart.—(*f*) Is the LEFT AURICLE, ſmaller, but more muſcular, and ſtronger than the right; it receives eaſily whatever quantity of blood the lungs convey to it; it is irritated, contracts, forces the mouth of the ventricle, and fills it with this purified and redder blood.—(*g*) Is the LEFT VENTRICLE, whoſe form is longer, its fleſhy walls thicker, its cavity ſmaller, its power greater far than that of the right ſide; this ventricle is thus ſmall that it may be eaſily filled and ſtimulated, and thus ſtrong that it may propel all the blood of the body.—(*h*) Is the AORTA or great artery of the body, ariſing from this left ventricle, juſt as the pulmonic artery ariſes from the right: the left ventricle, by its ſtrong and ſudden ſtroke, not only delivers itſelf of its own blood, but propels all the blood of the body, communicates its vibratory ſtroke to the extremeſt veſſels, and excites the whole; this is the greater circle or circulation of the body, as oppoſed to the ſhorter circulation or leſſer circle of the lungs.

That there are ſtrictly two hearts, is now clearly made out; they are different in office; there are two diſtinct hearts, two ſyſtems of veſſels, two kinds of blood, and two circulations. Theſe two hearts might have done their offices, though placed in the oppoſite ſides of the breaſt, it is in order to ſtrengthen mutually the effect of each other that they are joined; for the fibres of the two hearts intermix; they are both incloſed in one membranous capſule, viz. the pericardium; the veins, auricles, ventricles, and arteries, correſpond in time and action with each other, and harmonize in a very

very beautiful manner. But this, I believe, will be more eaſily explained by marking the ſucceſſion of motions, by a ſuite of figures placed upon the ſeveral parts of the heart, by which the ſucceſſive motions are performed.

In No. 4. I have joined the right and left hearts; both that it may be ſeen how the left heart locks in behind the right heart, how the right heart comes to be the anterior one, and how the aorta ſeems to ariſe from the centre of the heart while its root is covered by the great artery of the lungs; and alſo that the ſynchronous parts, *i. e.* the parts which beat time with each other may be correctly ſeen.—1. The CAVAS are receiving the blood from all parts of the body, and in the ſame inſtant the pulmonic veins are receiving blood from the lungs. 2. The RIGHT AURICLE is gradually filling with the contaminated blood of the body; the left auricle, marked alſo with a ſecond figure, is filling with purified blood from the lungs. 3. The RIGHT VENTRICLE is ſtimulated by its auricle, and throws its contaminated blood into the lungs; and in the ſame moment the left ventricle throws its purified blood over the body. 4. The PULMONIC ARTERY re-acts upon the blood driven into it by the heart; and in the ſame moment the aorta re-acts upon the blood thrown into it, and that re-action works it through all this great ſyſtem of veſſels from this the centre to all the extremities of the body.

Thus it is eaſy to perceive how the ſucceſſive actions accompany each other in the oppoſite ſides of the heart: 1. The two veins ſwell; 2. The two auricles are excited; 3. The two ventricles are filled with blood; 4. The two arteries take up and continue this pulſating action of the heart. It is thus that the two hearts aſſiſt and ſupport the actions of each other, and there ſeems almoſt a phyſical neceſſity for their being joined; yet on the very beſt authority, and after deliberate diſſection, we are entitled to affirm, that the heart is found, not with its apex ſharp and conical, but cleft; the two ventricles plainly diſtinct from each other and divided by a great ſpace. "Latro, quæ pœnas ſcelerum luebat, quando

quando exenteraretur a carnifice, cor habuit ſingularis figuræ, mucrone non acuto, ut fieri ſolet, ſed bifido; ut diſtincti ventriculi manifeſtius externa facie apparuerint, dexter nempe et ſiniſter, interjecto magno hiatu *."

OF THE PARTS OF THE HEART.

As yet I have explained only the general plan of the circulation, without having deſcribed thoſe curious parts which are within the cavities of the heart, and which ſupport the actions in this beautiful harmony and perfect order, each part ſubordinate to ſome other part, and each action ſucceeding ſome other action with perfect correctneſs, often without one unſteady motion or alarming pauſe, during the courſe of a long irregular life.

1. The VENÆ CAVÆ are two in number †; they are named venæ cavæ from their very great ſize; the one brings the blood from the upper, and the other from the lower parts of the body, and they are formed of theſe branches: the upper vena cava (*a*) is properly termed the DESCENDING CAVA, becauſe it carries the blood of the head and arms downwards to the heart: this great vein is properly a continuation of the right jugular vein, which joins with the right axillary vein, and then deſcends into the cheſt a great trunk; and in the upper part of the cheſt it is joined at (*b*)—by a great branch, containing the axillary and jugular veins of the left ſide, which, in order to reach the cava, croſſes the upper part of the cheſt, and lies over the carotid arteries. The lower VENA CAVA, or CAVA ASCENDENS, brings in like manner all the blood from the belly and lower

* Bartholini Epiſt. p. 170. There are examples in the lower animals, of the hearts being actually in diſtinct parts of the Syſtem.

† Let the reader obſerve, that the whole of this deſcription of the various parts of the heart is, as it were, an explanation of the plans N° 5. and 6; of which the N° 5. ſhows the right ſide of the heart, or the heart of the lungs opened; while N° 6. ſhows only the left heart, or the heart of the body opened.

parts of the body by two great branches. One, marked (*c*),—is the great vein which lies in the belly along the left ſide of the ſpine, and brings the blood from the legs, the pelvis, and parts of generation, the kidneys, &c.; it is named the VENA CAVA ABDOMINALIS, becauſe of its lying in the abdomen. Another, marked (*ddd*), —ariſes in three or four great branches from the liver; it is named the branches of the vena cava in the liver, or the VENA CAVA HEPATICA; and theſe two make up the lower cava; and the lower and the upper cavas now join themſelves at (*e*)—to form the right ſinus of the heart.

2. The RIGHT SINUS OF THE HEART, marked (*e*), is of conſiderable extent; it is juſt the gradual dilatation of the two veins forming the auricle or reſervoir which is inceſſantly to ſupply the heart; the veins grow ſtronger as they approach the ſinus, and the ſinus ſtill ſtronger as it approaches the AURICLE or notched and pendulous part (*f*), and the auricle again approaches in its nature to the ventricle of the heart; for it is croſſed with very ſtrong muſcular fibres, which make very deep riſings and furrows upon its inner part. To ſay that theſe veins, or the ſinus which they form, are not muſcular, merely becauſe they are not red nor fleſhy, is very ignorant; for the ureters, urethra, arteries, inteſtines, the iris, and many other parts of the human body, are, at the ſame time, perfectly muſcular and perfectly pale; and the heart of a fiſh is as tranſparent as a bubble of water, and yet is ſo irritable, that after it is brought from market, if you lay open the breaſt, and ſtimulate the heart with any ſharp point, it will renew its contractions, and in ſome degree the circulation.

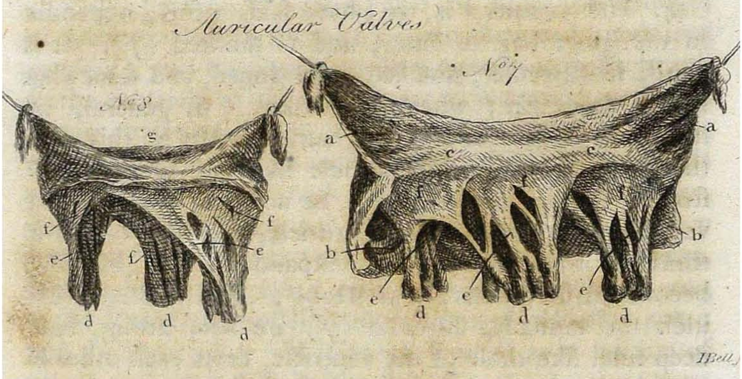
3. The TUBERCULUM LOWERI ſhould be looked for in this point, if it were not really an imagination merely of that celebrated anatomiſt. The whole matter is this; the two veins meet, not directly, but at a conſiderable angle within the vein, as at (*g*). Lower conceived a projection of the inner coats of the vein at this point much more conſiderable than what I have here repreſented. It was thought to do the office of a valve, to break the

force of the defcending blood, to defend from preffure that blood which is afcending from the lower cava, and to direct the blood of the upper cava into the right auricle of the heart. But there is no fuch thing; although anatomifts were at one time fo fond of this trivial obfervation, that not one of them would demonftrate the heart, without demonftrating the tuberculum Loweri; whereas, if the blood of the lower cava needs any fcreen above it to defend it from the preffure, it is (as I fhall fhow prefently) quite of another kind; and in the place appointed for finding this tuberculum Loweri we can find nothing but on the infide the natural angle of the two veins, and on the outfide fome fat cufhioned up in that angle in the line (*b*). Though generally wanting, I have found the tuberculum Loweri very diftinct in the human heart.

4. The AURICLE is, as I have faid, a fmall appendix to the great bag or finus, and is marked (*f*). It is fmall, femicircular, notched or fcolloped, and fomewhat like a dog's ear; whence its name. In general, we name the whole of this bag auricle; but by this plan the names of finus and auricle muft be eafily underftood. The point chiefly to be noted is this, that the veins, as they approach the auricle, are thin, delicate, tranfparent; that where they expand into the finus they become flefhy, thick, and ftrong; that in the auricle itfelf the mufcular fibres at (*f*) are very ftrong, have deep fulci like thofe of the ventricle, crofs each other fo as to make a net-work; and thefe ftrong fibres (*f*) are what are named the mufculi pectinati auriculæ. Where thefe mufcles run, as in cords, acrofs the auricle, they are very thick and opaque; but in the interftice of each ftripe or mufcular fibre, the auricle is tranfparent, like the membranes of the veins; and thefe ftripes of mufcular fibre which are laid upon this thin membrane are almoft as regular as the teeth of a comb; and thus they are named MUSCULI PECTINATI.

5. The VALVES of the AURICLE are placed at the circle (*i*), where the auricle enters into the ventricle, and the valves are marked (*k*): and how neceffary thefe are

are for regulating the movements of the heart, will be easily understood by considering the conditions in which the auricle and ventricle act. First, The cavæ pour in a flood of blood upon the sinus and auricle, with a continual pressure; the moment the auricle has contracted, it is full again; the pressure from behind excites it to act, and while it is acting there is no occasion for valves to guard those veins whose blood is pressing forwards continually, because they are continually full, and have behind them the whole pressure of the circulating blood. But when the auricle acts, it throws its blood into the ventricle, fills it, and stimulates it; the auricle then lies quiescent for a moment, while it is gradually filling from behind



Auricular Valves explained.

Fig. 7. shows the Auricle and Ventricle cut open, and the valve hanging in three great divisions.—(*a*) Part of the inside of the Auricle.—(*b*) Part of the inside of the Ventricle.—(*c*) The Tendinous Circle from which the membrane of the valve arises.—(*d*) The Columnæ Carneæ.—(*e*) The Cordæ Tendineæ.—(*fff*) The three great divisions of the Valve.——No. 8. shows the circle of the entrance of the Auricle still entire; where—(*g*)—marks the eutrance into the Auricle.—(*fff*) The three great divisions of the Valve.—(*d*) The Columnæ Carneæ; and—(*e*) The Cordæ Tendineæ.

behind with blood; but during this quiescent state the whole blood from the ventricle would rush back into it, were it not guarded by valves. The valves, then, which rise whenever the ventricle begins to act, are of this kind: there is, first, a tendinous circle or hole, by which the auricle communicates with the ventricle. The opening is large enough to admit two or three fingers to pass through it; it is smooth, seems tendinous, is plainly the place of union betwixt the auricle and ventricle, which are in the fœtus (in the chick, for example) distinct bags; and from all the circle of this hole arises a membrane, thin, and apparently delicate, but really very strong; not divided into particular valves at this root or basis, but as the membrane hangs down into the ventricle, it grows thinner, and is divided into fringes. How these fringes can do the office of valves is next to be explained. The tags and fringes of this membrane are actually tied to the inside of the ventricle by many strings, which being, like the valves, of a tendinous nature, are called CORDÆ TENDINEÆ, or tendinous cords; and these cords being attached to little processes projecting from the muscular substance of the heart, these processes are named COLUMNÆ CARNEÆ, or fleshy columns. Of these tyings of the valves there are three chief points; the whole circle seems to be divided into three sharp pointed valves; they are named VALVULÆ TRICUSPIDES, or three-pointed, or they are still sometimes called Triglochine Valves. The valves fall down easily when the blood goes down through them, and they rise readily and quickly whenever the blood gets behind them: when the ventricle is full the valves are still open, but when the ventricle contracts the blood throws up the valves, and closes the opening into the auricle, and now the tendinous cords and fleshy columns support the margins of the valves, so that they give them strength to support the heart's action.

6. The VENTRICLE of the RIGHT SIDE (*ll*) is like its auricle, larger than the same parts on the left side; for this auricle and ventricle of the right side have the weight of the whole blood of the body pressing upon them.

them. They are ſubject to occaſional fulneſs, for they muſt be dilated by many accidents, as labour, violent ſtruggles, &c. which ſend the blood too quickly upon the heart; while the left auricle and ventricle, on the other hand, can never be overloaded, as long as the pulmonic artery preſerves its natural ſize, for that artery continues always the meaſure of the quantity of blood which they receive. The ventricle is thick, ſtrong, and fleſhy. Its inner ſurface is extremely irregular; it puts out from every part of its ſurface very ſtrong fleſhy columns. Theſe fleſhy columns are irregular in ſize, big, ſtrong, running along the length of the ventricle; ſome croſs the ventricle, ſo as to connect its oppoſite walls together; ſome have the tendons of the valves fixed to them; all of them have perfect contractile power, and are indeed the ſtrongeſt muſcles of the heart. Betwixt the fleſhy columns, there are, of courſe, very deep and irregular grooves; and among the confuſed roots of theſe fleſhy columns the blood often coagulates after death, ſeldom before it, into the form of what are called polypi of the heart. Yet ſtill the walls of the right ventricle (*ll*)—are thinner, the fleſhy columns ſmaller, the cavity greater, than thoſe of the left ſide; the right ventricle of the heart has alſo a peculiar form, for the SEPTUM CORDIS, a partition betwixt the right and left heart, is not, as generally ſuppoſed, a part common to both; but the left ventricle is much longer, and more conical than the right one; the ſeptum belongs almoſt entirely to the left ventricle; the right ventricle, which is much bigger, laxer, flatter, and thinner in the walls, is, as it were, wrapped round the left; and thus the left ventricle alone forms the acute apex of the heart, and the left ventricle of neceſſity bulges very much into the cavity of the right, ſince the right ventricle is ſo much larger, and in a manner wrapped round it. In both ventricles, it is very remarkable, that towards the opening of the auricle the ſurface of the ventricle is very rugged, irregular, and croſſed with columnæ carneæ, while a ſmooth and even lubricated channel marked (*m*)—leads towards the artery.

7. The

7. The PULMONIC ARTERY arifes from the right ventricle, to carry out the blood clofe by the great opening at which the auricle pours it in; the artery rifes at its root in a very bulging triangular fhape. It is the valve within the mouth of the artery that gives it this very peculiar fhape without; for the bulging root is divided into three knobs, indicating the places of the three valves, the artery dilating behind each valve into a little bag, which, when it is defcribed, is called its finus.

8. This VALVE of the PULMONIC ARTERY (*n*)—has a more perfect and fimple form than that of the auricle. The valves in the mouth of each of the great arteries are three in number; they are thin but ftrong membranes, rifing from the circle of the artery, where it comes off from the heart: each valve is femilunar; its larger and loofer edge hangs free into the cavity of the artery; the edge is a little thicker than the reft of the valve; the three valves together form one perfect circle, which clofes the mouth of the artery fo that no groffer fluid, nor hardly air can pafs. When they are filled till they become very tenfe, each valve forms a kind of bag; fo that when you look at the mouth of a dried artery, they appear like neat round bags; and when they are likely to be forced, the little horns or tags by which each valve is fixed into the coats of its artery, become fo tenfe as to do the office of a ligament: thefe are called the SEMILUNAR or SIGMOID VALVES.

Now the condition of the ventricle while it is contracting is well underftood: the auricle by its action lays down the tricufpid or auricular valve, and fills the ventricle; the ventricle cannot feel the ftimulus of fulnefs till its valves rife and its cordæ tendineæ begin to pull; and the ventricle could not be clofe for acting, nor its walls perfect, it could not in fhort be an entire cavity, till the tricufpid or auricular valves were completely raifed. But there is another opening of the ventricle, viz. that into the artery, which muft be alfo fhut; this is one of the feveral inftances of the fubordination of thefe actions one to another; for firft the auricle acts, then the ventricle, then the artery; fo that the auricle and

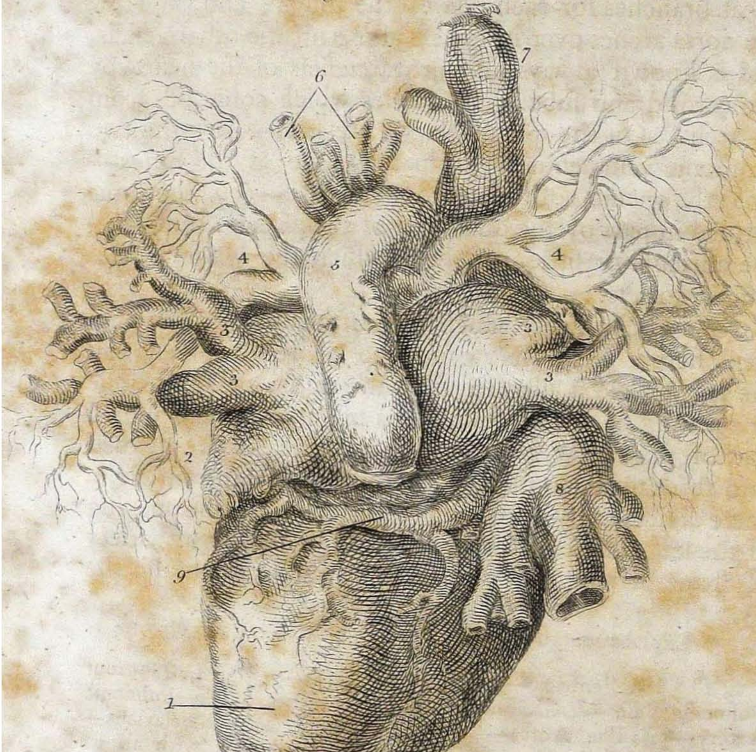
and the artery are acting in the ſame moment of time; the artery by acting throws down its valve, and cloſes that opening of the ventricle, while the auricle is filling it with blood; and again, the moment that the ventricle is filled, both the auricle and artery are in a ſtate of relaxation, the auricular valve riſes ſo as to cloſe the ventricle on that ſide; and the arterial valve falls down, both becauſe the artery has ceaſed acting, and becauſe the valve is laid flat by the whole blood of the ventricle ruſhing through it. Hence it is very obvious, that the right ventricle could neither be filled nor ſtimulated, unleſs the opening toward the artery were cloſe during the time of its filling; and again, it is obvious that this valve cannot be laid down by any other power than that of the artery itſelf; who then can doubt that the artery has in itſelf (like the ventricle) a ſtrong contractile power? That it is the ſtroke of the artery ſucceeding that of the heart that lays down this valve ſo cloſely, is proved by this, that in many animals, in fiſhes for example, the aorta is as plainly muſcular as the heart itſelf, it is like a ſecond heart; and in fiſhes the veſſel returning from the gills, and often in human monſters, the artery alone, by its own muſcular power, moves the whole circulation without any communication with the heart. In fiſhes there is no ſecond heart for the circulation of the body; and in monſters the heart is ſometimes wanting, and there is found nothing but a ſtrong aorta to ſupply its place. This ſtroke of the pulmonic artery, then, (which the heart excites,) puſhes the blood through the leſſer circle or circulation of the lungs, and by the pulmonic veins it is poured into the left ſide of the heart.

9. The LEFT AURICLE of the heart is unlike the right auricle in theſe reſpects: the ſinus, or that part which conſiſts of the dilatation of the pulmonic veins, is ſmaller, while the auricula, which is the more muſcular part, is larger; the pulmonic veins come in four great trunks from the lungs, two from the right ſide and two from the left; two great veins then enter at each ſide of the left auricle, by which it gets a more ſquare form; the

Sketch

Representing the Backpart of the Heart — The great Coronary Vein — The Shape of the left Auricle — and the entrance of the Pulmonary Veins

Nº 9



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the whole of the left ſinus, which forms the chief bulk of this part, is turned directly backwards towards the ſpine, and is not to be ſeen in any common view of the heart; but I have here added a plan of the back part of the heart*, ſhewing, 1. How the left ventricle lies behind; 2. How the left auricle is turned ſtill more directly backwards; 3. How the pulmonic veins enter into it in four great branches, ſo as to give a ſquare or box-like form, compared with the gliding, gentle ſhape of the right auricle; 4. How the pulmonic artery comes out from under the arch of the aorta, dividing into its two great branches for each ſide of the lungs; and, 5. How the aorta arches over it, towers above all the other veſſels, and is known always among the veſſels of the heart by the carotid and ſubclavian arteries which come off from its arch. On the plan, No. 6. are ſeen—(*oo*) the two pulmonic veins entering from each ſide of the lungs—(*pp*) the opening of theſe into the auricle—(*qq*) the ſinus formed in part by the dilatation of theſe veins, and,—(*r*) the auricula or little ear, from which the whole bag is named auricle.

10. The valves which guard the left auricle are ſeen here † (*ss*):—Now it is to be remembered that the left auricle is ſmaller than the right, that the circle or opening of the left auricle is of courſe ſmaller than that of the right; that while it requires a valve divided into three points to fill the opening of the right auricle, a valve divided only into two points ſuffices for the opening of the left auricle; this is the reaſon of this ſlight variety of ſhape betwixt the two auricular valves, and is alſo the reaſon

* Explanation of the BACK VIEW of the HEART, N° 9.

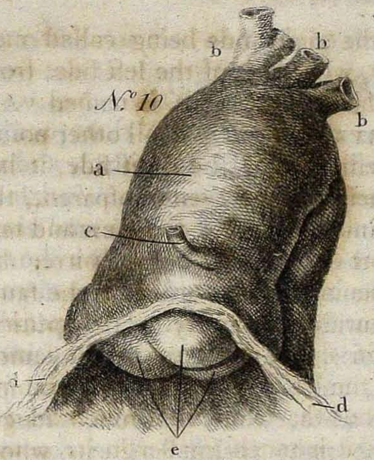
1, The left Ventricle—2, The left Auricle—3 3 3 3, The four Pulmonic Veins—4 4, The two great branches of the Pulmonic Artery—5, The Aorta—6, The Carotids and Subclavians—7, The Cava Deſcendens—8, The Cava Aſcendens, with all its branches from the Liver—9, The great Coronary Vein running along the back of the Heart betwixt the Auricle and Ventricle in a groove ſurrounded by fat.

† This begins the deſcription of the left ſide of the Heart, and the deſcription follows the plan, N° 6.

reaſon of the valve of the right ſide being called TRICUSPID or three-pointed, while this of the left ſide, from ſome very ſlight reſemblance to a mitre, is named VALVULA MITRALIS, the MITRAL VALVE. In all other points this valve is the ſame with that of the right ſide, it has the ſame apparent thinneſs, for it is even tranſparent, the ſame real ſtrength, the ſame COLUMNÆ CARNEÆ and tendinous ſtrings to ſupport it; the ſame rough irregular ſurface towards the opening of the auricle; the ſame ſmooth gutter leading towards the artery. The conſtitution of all theſe parts, in ſhort, is expreſsly the ſame; ſo that even concerning the left ventricle there is nothing further to be obſerved, but that while it is much longer than the right ventricle, it is much ſmaller in its whole cavity, is much ſtronger in its COLUMNÆ CARNEÆ, and much thicker in its fleſhy walls, as at (*tt*) where it is ſeen to be thicker than the right ventricle, it is indeed nearly three times as thick.

11. The SEMILUNAR VALVES of the aorta are alſo ſeen in this general plan at (*u*)—where manifeſtly the general ſtructure, and general intention of the valves are the ſame as in thoſe of the pulmonic artery; but ſtill we find at every point marks of ſuperior ſtrength and more violent action in the left ſide of the heart; for though this valve be expreſsly like that of the pulmonic artery, and named like it ſemilunar, yet it is thicker and ſtronger in its ſubſtance, and is peculiarly guarded by three ſmall hard tubercles, which being placed one in the apex or point of each valve, meet together when the valve is cloſe, and give a more perfect reſiſtance to the blood, and prevent the valve being forced open. Theſe are to be ſeen chiefly in the marginal drawing; and from their being of the ſize of ſeſamum ſeed, they have the name of CORPORA SESAMOIDEA; ſometimes they are named Corpuſcula Arantii.

12. The AORTA ariſes from its ventricle very large and ſtrong; it ſwells ſtill more at its root than the pulmonic artery does; the three ſubdiviſions of this ſwelling, which mark the places of the ſemilunar valves, are very



very remarkable; the curvature at the arch of the aorta is called its great ſinus, and theſe three ſmaller bags are called the three leſſer ſinuſes of the aorta.

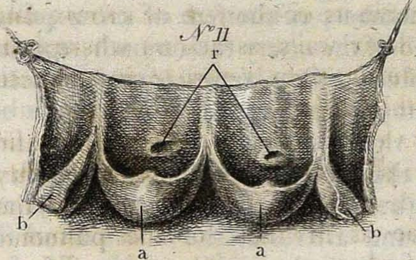
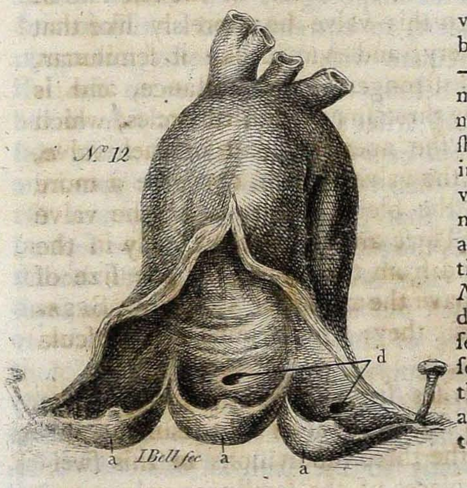


Fig. 10. ſhows the aorta entire, but its root within the heart opened ſo as to ſhow its valve—(*a*) The body of the aorta; the arch is marked by *bb*, the carotids and ſubclavians—(*c*) Shows one of the coronary arteries or artery of the heart.—(*d*) A part of the walls of the heart—(*e e e*) The three valves ſtuffed and turgid towards the heart.——N° 11, ſhows the lower part of the aorta cut open; and two of the valves—(*aa*)—entire; and the third valve—(*bb*)—cut in two by ſlitting up the artery.—And (*rr*) ſhows the mouths of the two coronary arteries.——N° 12, ſhows the aorta ſlit only in its lower part, and the valves (*aa*) and the mouths of the coronary arteries (*bb*) are ſeen in their natural ſituation.—*N. B.* In theſe two laſt drawings the corpora ſeſamoidea are diſtinctly ſeen in the central part of the edge of each valve, and they need no letter to diſtinguiſh them.



Of

Of the CORONARY VESSELS.

But there ſtill remains to be explained that peculiar circulation by which the heart itſelf is nouriſhed, and yet there is nothing in it very different from the uſual form of arteries and veins; it is a part of the general circulation of the body, for the heart is nouriſhed by the two firſt branches which the aorta gives off. The circulation deſtined for the nouriſhment of the heart is peculiar in this chiefly, that the forms of the arteries and veins of the heart are beautiful, and that the arteries riſe juſt under the valves of the aorta, while the veins end with one great mouth in the right auricle. The coronary arteries are two in number, of the ſize of crow-quills; we ſee from the inſide of the artery their mouths opening above the ſigmoid valves. One artery comes from the lower ſide of the aorta; it lies towards the right; it belongs chiefly to the right ventricle; it comes out firſt betwixt the roots of the aorta and pulmonic arteries; it paſſes in the furrow betwixt the right ventricle and auricle, and turning round arrives at the back part of the heart, and runs down along the middle of that flat ſurface which lies upon the diaphragm; and when it arrives at the apex of the heart, its extreme arteries turn round the point and inoſculate with the oppoſite coronary. The other coronary belongs in like manner to the left ſide of the heart, and ariſes from the upper ſide of the aorta; it firſt goes out betwixt the pulmonic artery and the left auricle, and then turning downwards upon the heart, it runs along that groove which is betwixt the ventricles, and marks the place of the partition or ſeptum ventriculorum; its chief branches turn towards the left ventricle, and branch out upon it; it belongs as peculiarly to the left ſide of the heart as the other does to the right ſide: after ſupplying the left ventricle, &c. it turns over the point of the heart to meet the extremity of the firſt, and inoſculate with it. Both theſe arteries give branches not only to the fleſh of the ventricles, but

but to the auricles, and alſo to the roots of the great arteries, conſtituting the VASA VASORUM, as ſuch minute branches ſent to veſſels are called.

The GREAT CORONARY VEIN which collects the blood of theſe arteries, ariſes in ſmall branches all over the heart; theſe meet ſo as to form a trunk upon the forepart of the heart, where the ſeptum or union of the ventricles is. While ſmall, the veins accompany their reſpective arteries; but after the great trunk is formed, the vein takes its own peculiar route. When the trunk of the great coronary vein (accompanied by ſeveral leſſer veins) arrives at the auricle, it runs in between the left auricle and left ventricle; it turns all round the back of the auricle till it gets to the right ſide of the heart; it lies in the deep groove betwixt the auricle and ventricle, ſurrounded with much fat; and having almoſt entirely encircled the heart, it diſcharges its blood into the right auricle, cloſe by the entrance of the lower cava. The opening is very large; it lies juſt above the tendinous circle of the auricle, and it is guarded with a ſtrong ſemilunar valve. This is the great coronary vein; all the veins which appear upon the heart are but branches of it; what are called the MIDDLE vein of the heart, the vein of the right auricle, the vena innominata, &c. are all but branches of the great coronary vein running along the right ſide or lower ſurface of the heart; if there were to be any marked diſtinction, it ſhould be into the GREAT CORONARY VEIN belonging to the left ſide of the heart, and the VENA INNOMINATA belonging to the right ſide. But one thing more is to be obſerved; viz. that upon the inner ſurface of the right auricle may be ſeen many ſmall oblique and very curious openings, which ſerve for the mouths of veins, while their obliquity performs the office of a valve. This name of coronary veſſels is a very favourite one with anatomiſts, and is applied wherever veſſels ſurround the parts which they belong to, however little this encircling may be like a crown; and it is thus that we have the coronary arteries of the ſtomach, coronary arteries of the lips, and coronary

arteries

arteries of the heart. But theſe veſſels of the heart are really very beautiful, and have ſome things very peculiar in their circulation: firſt, with regard to the coronary arteries, they lie with their mouths under the ſigmoid valves; or at leaſt in ſo equivocal a manner, that their peculiar poſture has given riſe to violent diſputes; viz. Whether they be filled, like all the other arteries, by the ſtroke of the heart, or whether they be covered by the valve ſo as to let the blood ruſh paſt them during the action of the heart.

We ſee the opening of the coronary arteries rather, as I imagine under the valve; though Haller ſays they are above the valve, and that the higheſt point to which the margin of the valve reaches in very old men is below the opening of the coronary artery, and half way betwixt it and the bottom of the ſinus or little bag behind the valve. But let this be as it will, if the condition of the aorta be conſidered, it will be found to make no difference; for though the valves riſe and fall, are at one time fully opened, and at another time cloſely ſhut, ſtill in both theſe conditions of the valve the aorta is as full as it can hold; its contraction inſtantaneouſly follows that of the heart, but its contraction is not, like that of the heart, ſuch as to bring its ſides together; on the contrary, the aorta is full when the heart ſtrikes, the action of the heart diſtends it to the greateſt degree, the aorta re-acts ſo as to free itſelf of this diſtention, but ſtill it remains in ſome degree full of blood; elſe how could this, like every other artery, preſerve always its form and apparent ſize? In this condition of matters, it is obvious that the coronary branches are on the ſame footing with all the other branches of the aortic ſyſtem; that like all the other arteries, they firſt feel the ſtimulus of fulneſs from the puſh of the heart, and along with it the ſtroke of the aorta.

Secondly, with regard to the coronary veins a diſpute has ariſen more violent than this; for it has been doubted whether the coronary veins, large as they are, do actually convey the whole of the blood which the coronary

coronary artery gives out. Veuſſens believed that ſome of the coronary arteries opened directly into the cavities of the heart, without the interpoſition of veins. Thebeſius, after him, believed that there were ſome ſhorter ways by which the blood was returned; not by a long circle into the right auricle, but directly into the ventricles of the heart. Veuſſens, Thebeſius, and others who belonged to their party, pretended to prove this fact by injections: But what doctrine is there which ſuch clumſy anatomy and awkward injections may not be made to prove? They uſed mercury, tepid water, and air; and they forced theſe, the moſt penetrating of all injections, till they exuded upon the inner ſurface of the heart; but if they had fixed their tubes, not into the coronary artery, but into the aorta, and had proceeded to inſpect, not the heart, but all the viſcera of the body, they would have found their injections exuding from every ſurface; of the pleura and lungs; of the peritoneum, and inteſtines; of the brain, and dura mater; of the mouth, and tongue; and univerſally through the cellular membrane of the whole body; but if any coarſe injection, as tallow or wax, be uſed, following this natural courſe, it keeps within the arteries and veins, and if thin and well prepared, finds its way back to the auricle of the heart; but this injection alſo is extravaſated and is found in the cavities of the heart.

Du Verney was ſo far engaged in this queſtion, that having an opportunity of diſſecting the heart of an elephant, he tied up the coronary arteries and veins, waſhed and cleaned very thoroughly the cavities of the heart; and then tried, by ſqueezing, and all kinds of methods, to make that blood which was tied up in the coronary arteries and veins exude upon the inner ſurface of the heart, but with no effect.

On the preſent occaſion, a theoretical anſwer happens to be as ſatisfactory as the moſt correct experiments: and it is this, If there really were to be formed (by diſeaſe for example) thoſe numerous openings which Thebeſius and Veuſſens deſcribe, then the blood flowing

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all by theſe ſhorter and eaſier paſſages, none could come to the great coronary vein; its office would be annihilated; and itſelf, contracting gradually, would ſoon ceaſe to exiſt.

Of the EUSTACHIAN VALVE.

There remains to be explained in the mechaniſm of the heart one point; and which I have ſeparated from the others; not becauſe it is the leaſt important, but becauſe it is the moſt difficult, and, if I may be allowed to ſay ſo, not yet thoroughly underſtood,; I mean the anatomy of the EUSTACHIAN VALVE; which, if it had been eaſily deſcribed, ſhould have been firſt deſcribed; for it is a valve which lies in the mouth of the lower cava, juſt where that vein enters the right auricle of the heart. How imperfect a valve this is, how difficult to diſſect or to explain, may eaſily be known from this, that Winſlow was firſt incited to look for the valve by ſome hints in Sylvius; he was ſoon after fairly directed to it by finding it in the tables of the Euſtachius, which were then firſt found and publiſhed by Lanciſi, after the author had been dead 150 years; and yet with all this aſſiſtance Winſlow ſought for it continually in vain, till at laſt he reflected, that by cutting the heart in its fore-part, he muſt have always in his diſſections deſtroyed any ſuch valve; by opening the back part of the cava he at laſt ſaw the valve, and demonſtrated it to the Academy of Sciences in France; and having juſt received from Lanciſi his edition of the Euſtachian Table, ſo long hidden, and ſince ſo outrageouſly praiſed, he called it VALVULA EUSTACHIANA, a name which it has retained to this day, and he added RETICULARIS, to expreſs its lace-like netted appearance at its upper edge. From Winſlow's time to this preſent day, that is, for eighty years, there has been no good drawing, nor even any perfect deſcription of the valve; and in the confuſion of opinions upon the ſubject, what its uſe may be no one knows.

The Euſtachian valve lies in the mouth of the aſcending cava, juſt where that great vein is joined to the auricle of the heart. It looks as if formed merely by the vein entering at an acute angle, and by the inner edge of the vein, or that which is joined to the auricle, riſing high, ſo as to do the office of a valve. The very firſt appearance of the valve, and its place juſt over the mouth of the cava, ſeems to point out that uſe which Lanciſi has aſſigned it, viz. to ſupport the blood of the upper cava, and prevent that column of blood which deſcends from the cava gravitating upon the oppoſite column which comes from the liver and lower parts of the body; and yet this, moſt likely, is not its uſe. The valve ſomewhat reſembles a creſcent, or the membrane called hymen. It occupies juſt that half of the cava which is neareſt the auricle. Its deepeſt part hangs over the mouth of the cava, and is nearly half an inch in breadth, ſeldom more, often leſs, ſometimes a mere line. Its two horns extend up along the ſides of the auricle; the poſterior horn ariſes from the left of the iſthmus, as it is called, or edge of the oval hole; its anterior horn ariſes from the vena cava, where it joins the auricle. Behind the valve the remains of the foramen ovale may be ſeen, now ſhut by its thin membrane, but ſtill very eaſily diſtinguiſhed; for its arch-like edges are ſo thick, ſtrong, and muſcular, that they look like two pillars, and thence are called the COLUMNÆ FORAMINIS OVALIS: theſe two pillars were called ISTHMUS VIEUSSENII, and by Haller are named ANNULUS FOSSÆ OVALIS, while the remains of the hole itſelf is ſo deep that it is named the FOSSA OVALIS. Before the Euſtachian valve lies the great opening into the ventricle; but betwixt that and the valve there is a foſſa or hollow, in which lies the opening of the great coronary vein; and the valve which covers the coronary vein is a neat ſmall ſlip of white and very delicate membrane, the one end of which connects itſelf with the fore-part of the Euſtachian valve; ſo that both valves are moved and made tenſe at once.

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The Euſtachian valve is in general thick and fleſhy; it is ſometimes reticulated or net-like even in the fœtus, but by no means ſo often as to vindicate Winſlow, in adding reticulare to the name; it grows reticulated chiefly in the adult. The only beautiful drawing that we have of a reticular Euſtachian valve is in Cowper; and that was from a man of eighty years of age. Perhaps in eight or ten hearts you will not find one that is reticulated in the leaſt degree; in old men it is reticulated, juſt as all the other valves of the heart are, not by any thing peculiar to the conſtitution of this valve; not by the preſſure of the blood and continual force of the veſſels, as Haller repreſents; but by the gradual abſorption which goes on in old age, and which ſpares not the very bones, for even they grow thin and in many places tranſparent.

This is the ſimple deſcription of a valve, which has been the occaſion of more controverſy than the circulation of the fœtus and the uſe of the oval hole. Winſlow firſt began about eighty years ago to obſerve the connections and uſes of this valve; he laid it down as an abſolute fact that this valve was almoſt peculiar to the fœtus; that it was perfect only while the foramen ovale was open; that it vaniſhed gradually as the foramen ovale cloſed; that in the adult it was ſeldom ſeen unleſs the foramen ovale was alſo open by chance. It is incredible what numbers of anatomiſts followed this opinion; for the difficulty of diſſecting the valve made it always eaſier to ſay that it was only in the fœtus that it could be found: it is alſo incredible what abſurd conſequences aroſe from this doctrine, which, after all, is but a dream, for in fact the valve is more eaſily ſhown in the adult heart *.

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* One author, I find in the Acta Vindobonenſia, is exceedingly angry indeed with all the great anatomiſts, for not connecting more ſtrictly with each other the anatomy and accidents of the foramen ovale, and Euſtachian valve; with Morgani, Albinus, and Wiedbriecht, he is offended for ſaying that they had ſeen the foramen ovale

The foundation being now laid for connecting this valve with the peculiar circulation of the fœtus, they conceived the following theory, which has come down to this very day; viz. that in the child the great object of nature, in arranging its veſſels, was to convey the blood which came freſh from the mother's ſyſtem directly into the carotids, and ſo plump into the head at once. The pure blood from the mother comes through the liver by the ductus venoſus; it is depoſited in the lower cava at the right ſide of the heart; and theſe anatomiſts ſuppoſed that this current of freſh blood was directed by the Euſtachian valve into the oval hole, through that into the left auricle and ventricle, and from theſe directly into the aorta and carotids; while the foul blood of the upper cava went down into the right auricle and ventricle, and from that into the ductus arterioſus, and ſo away down to the lower and leſs noble parts of the body, and to the umbilical arteries, and ſo out of the ſyſtem; for the ductus arterioſus, which comes from the right ventricle in the fœtus, joins the aorta only as it goes down the back, and none of its blood can paſs upwards into the head.

This is the puerile theory, which, modified in various ways, has amuſed the French Academy, or rather been the cauſe of a perpetual civil war in it, for a hundred years. This doctrine began with Winſlow, it is ſtill acknowledged by Sabbatier; and Haller, after announcing a theory not at all differing from this, challenges it

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ovale open, without ſaying one word concerning the ſtate of this valve; and with Lieuteaud, Portal and others again, he is equally offended that they ſhould have had opportunities of ſeeing the Euſtachian valve entire without enquiring into the condition of the oval hole. The reaſon of all this is very plain; the oval hole had not been open, neither in the one ſituation nor in the other, elſe it is very unlikely that ſuch correct and anxious anatomiſts ſhould have deſcribed that valve which ariſes from one of the borders of the oval hole, without obſerving it open, if it was ſo; eſpecially as the oval hole, being open, is by no means an uſual occurence.

as his own theory; " hanc meam conjecturam etiam a Nichols video proponi." Of the truth of this theory Haller was ſo entirely ſatisfied, that he not only publiſhed it as peculiarly his own, but reclaimed it when he thought it in danger of being thus appropriated by another. Sabbatier is the laſt in this train of authors; and in order that there might remain no ambiguity in what they had ſaid or meant, he pronounces plainly that the Euſtachian valve is uſeful only in the fœtus, and that there are two oppoſite currents in the right auricle of the heart; that the one goes from the lower cava upwards to the foramen ovale, while the other from the upper cava deſcends right into the opening of the ventricle. What ſhall we ſay to anatomiſts who in the narrow circle of the auricle conceive two currents to croſs each other directly, and to keep as clear of each other as the arrows by which ſuch currents are uſually repreſented. This error in reaſoning is below all criticiſm; it carries us backwards a hundred years in anatomy and in phyſics; and yet this is all that Winſlow, Haller, Sabbatier, and a mob of others, have been able to ſay in proof of the connection of the Euſtachian valve with the circulation of the fœtus.

Lanciſi, again, believed that it was chiefly uſeful by ſupporting the blood of the lower cava, defending it from the weight of that column of blood which is continually deſcending from above; and Winſlow and others approved of this, as being perhaps one uſe of the valve. But they have all of them forgotten a little circumſtance, which muſt affect the office of the valve, and which ſhould have been regarded eſpecially by thoſe who ſaid it was uſeful chiefly before birth; they have forgotten a little circumſtance, which John Hunter alſo forgot, when theoriſing about the gubernaculum teſtis, viz. that the child lies with its head downmoſt for nine months in the mother's womb.

Nothing is more certain than that the Euſtachian valve is not peculiar to the fœtus; that it has no connection

Drawing of the Eustachian Valve from the heart of a Child about 3 or 4 years old

a. A part of the Lungs. b.b. The Pericardium by which the Heart is suspended. c.c. The Ventricles of the Heart. d.d. The Aorta encircled by the Pericardium. e.e.e.e. The Subclavian and Caroted Arteries ~ g the Pendulous part of the Right Auricle h The Cava descendens by wh. the Heart is in part suspended. ii. The Cava ascendens with a pencil passed up into the Right Auricle. this pencil is behind the Eustachian Valve The Eustachian Valve itself is marked k. The little Valve of the Coronary Vein which is connected with it is marked m.

I Bayss

nection with the oval hole; that the valve is often particularly large after the foramen ovale is closed; that the valve is often obliterated where yet the foramen ovale remains open; that in adults it is more easily demonstrated than in children; that in old age it is often reticulated as the other valves are. Its use relates neither to the foramen ovale, nor to the ascending cava; it relates to the auricle itself, and therefore it is found in all the stages of life, smaller or larger according to the size or form of the heart.

The auricle on the side towards the venæ cavæ is imperfect; the anterior part of the auricle chiefly is muscular, and when it contracts, the laxity of the cavas and the great width of the SINUS VENOSUS, *i. e.* of almost the whole auricle, would take away from its contraction all effect; but to prevent this, and to make the auricle perfect, the vena cava, and auricle meet so obliquely, that the side of the cava makes a sort of wall for the auricle on that side. This wall has entirely and distinctly the reticulated structure of the auricle itself, with fleshy bands of muscular fibres in it: this wall falls loosely backwards when the auricle is quite relaxed, as, for example, when we lay it open; and thus it has got the appearance and name without the uses of a valve; but when the heart is entire, tense, and filled with blood, this valve represents truly a part of the side of the auricle: and that this part of the wall of the auricle should be occasionally a little higher or lower, looser or tenser, we need not be surprised. This further may be observed, that wherever, as in a child, this valve is very thin and delicate, the anterior part of the fossa ovalis goes round that side of the auricle particularly deep and strong. Let it also be remembered, that in certain animals this valve is particularly large and strong; now, in a creature which goes chiefly in a horizontal posture, it may strengthen and make up the walls of the auricle (the chief use which I have assigned for it in man); but surely it cannot protect the blood of the lower cava from the weight of blood coming from above, since the body of

of an animal lies horizontally, and there is no ſuch weight. The Pariſian academicians deſcribe the heart of the Caſtor in the following terms: "Under the vena coronaria we find the valve called nobilis (viz. the Euſtachian valve), which fills the whole trunk of the vena cava, and which is ſo diſpoſed that the blood may be eaſily carried from the liver to the heart by the vena cava, but which is hindered from deſcending from the heart towards the liver through the ſame vein *."

* EUSTACHIAN VALVE.

N° 14. explains merely the place of the Euſtachian valve, which is ſeen at (*m*).—N° 15. explains both the place of the valve and its relation to the oval hole (*e*)—behind it, and to the mouth of the ventricle (*n*)—which lies before it.

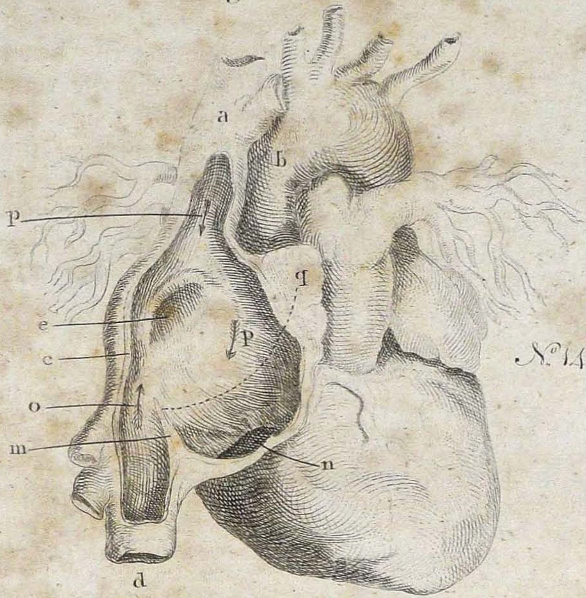
In both theſe plans—(*a*) Is the cava deſcendens—(*b*) The aorta riſing behind it—(*cc*) The back of the auricle ſlit open—(*d*) The cava aſcendens, in the mouth of which the valve is—(*e*) The foramen ovale—(*ff*) Its two riſing borders, named pillars, iſthmus of Vieuſſens, annulus ovalis, &c.—(*m*) The Euſtachian valve, of which the two cornua, or ſharp points, are ſeen in the lower plate, terminating in the pillars of the foramen ovale on one hand, and in the walls of the auricle on the other. The opening of the foramen ovale (*e*)—is behind and above the valve; the opening into the right ventricle (*n*)—is before and under the valve.

N° 14. explains more particularly the uſes of the valve. Some authors conceived that it directed the blood riſing in the line (*o*)—upwards into the oval hole; others that it directed the column of blood, repreſented by the arrow (*p*)—into the right ventricle; others that it protected the column (*o*)—from the weight of the column (*p*).—I rather ſuppoſe that it completes the auricle in the direction of the dotted line (*q*)—and ſo ſtrengthens its action.

OF THE IRRITABILITY AND ACTION OF THE HEART.

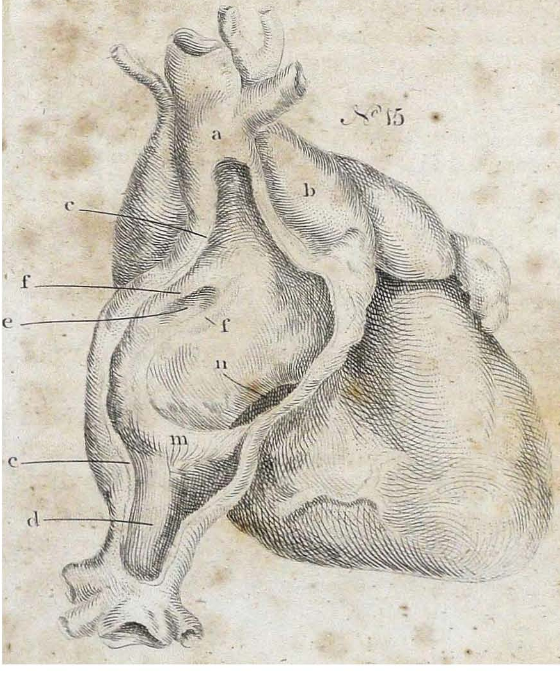
But even this curious mechaniſm of the heart is not more wonderful than its inceſſant action, which is ſupported by the continual influx of ſtimulant blood, and by its high irritability and muſcular power; for though we cannot directly trace the various courſes of its muſcular fibres, there is not in the human body any part in which

Plans of the Eustachian Valve



No. 14

No. 15



which the muſcular ſubſtance is ſo denſe and ſtrong. In the heart there can be no direct or ſtraight fibres; for let them go off from the baſis of the heart in what direction they may, ſtill as they belong to the one or the other ventricle, they muſt by following the courſe and ſhape of that ventricle, form an oblique line. Veſalius has indeed not repreſented them ſo, he has drawn ſtraight fibres only; becauſe in the latter end of his great work he was without human ſubjects, and betook himſelf to drawing from beaſts.

The fibres of the heart are all oblique, or ſpiral, ſome lying almoſt tranſverſe; they all ariſe from a ſort of tendinous line which unites the auricle to the ventricle; they wind ſpirally down the ſurface till the fibres of the oppoſite ventricles meet in the ſeptum and in the apex of the heart. The fibres of each ventricle paſs over the convex or upper ſurface of the heart, then over the apex, and then aſcend along the flat ſide of the heart, which lies upon the diaphragm, till they again reach the baſis of the heart. The ſecond layer or ſtratum of fibres is alſo oblique; yet many of the fibres run almoſt tranſverſely, uniting the oblique fibres; but when we go down into the thick ſubſtance of the heart, we find its fibres all mixed, croſſed, and reticulated in a moſt ſurpriſing manner; ſo that we at once perceive both that it is the ſtrongeſt muſcle in the body, and that the attempt to extricate its fibres is quite abſurd *. Their deſire of giving more correct and regular deſcriptions has been the cauſe why thoſe who have particularly ſtudied this point have been fatigued and diſappointed; the moſt ſenſible of them have acknowledged with Veſalius, Albinus, and Haller, that the thing could not be done; while thoſe, again, who pretended to particular accuracy, and who have drawn the fibres of the heart, have repreſented to us ſuch extravagant, groſs, and prepoſterous things, as have ſatisfied us more than their moſt

* Thickening the walls of the heart by vinegar, ſtrong acids, alum, or boiling the heart, have aſſiſted us in unravelling its ſtructure but very little.

 ingenuous

ingenuous acknowledgments could have done, that they alſo could accompliſh nothing.

There is no queſtion that irritability is variouſly beſtowed in various creatures, that it is variouſly appointed in various parts of the body, that this property riſes and falls in diſeaſe and health; without heſitation we alſo may pronounce that the heart is in all creatures the moſt irritable part; it is the part firſt to live and the laſt to die: "Pulſus et vita pari ambulant paſſu." When we ſee the punctum ſaliens in the chick, we know that there is life; and when we open the body of an animal ſoon after death, ſtill the heart is irritable and contracts.

In the very firſt days in which the heart appears in the chick, while yet its parts are not diſtinguiſhed, and the punctum ſaliens is the only name we can give it, the heart, even in this ſtate, feels the ſlighteſt change of heat or cold; it is rouſed by heat, it languiſhes when cold, it is excited when heated again. It is ſtimulated by ſharp points or acids, it works under ſuch ſtimuli with a violent and perturbed motion. In all creatures it ſurvives for a long while the death of the body; for when the creature has died, and the breathing and pulſe have long ceaſed, and the body is cold, when the other muſcles of the body are rigid, when the ſtomach has ceaſed to feel, when the bowels which preſerve their contractile power the longeſt have ceaſed to roll, and they alſo feel ſtimuli no more, ſtill the heart preſerves its irritability; it preſerves it when torn from the body and laid out upon the table; heat, cauſtics, ſharp points, excite it to move again.

We know alſo another thing very peculiar concerning the irritability of this organ, viz. that it is more irritable on its internal than on its external ſurface; for if inſtead of cutting out the heart we leave it connected with the body, ſeek out (as the old anatomiſts were wont to do) the thoracic duct, or pierce any great vein, and blow a bubble of air into the heart, it purſues it from auricle to ventricle, and from ventricle to auricle again, till, wearied and exhauſted with this alternate action, it ceaſes at laſt, but ſtill new ſtimuli will renew its force.

Thus

Thus it is long after apparent drowning or other ſuffocation before the principle of life is gone; and long after the death of the body before the heart be dead; and juſt as in this peculiar part of the ſyſtem irritability is in high proportion, there are in the ſcale of exiſtence certain animals endowed in a wonderful degree with this principle of life. They are chiefly the amphibious creatures, as they are called, needing little air, which have this power of retaining life; no ſtimuli ſeem to exhauſt them, there ſeems eſpecially to be no end to the action of their heart; a Newt's or a Toad's heart beats for days after the creature dies; a Frog, while uſed in experiments, is often neglected and forgotten, its limbs mangled, and its head gone, perhaps its ſpinal marrow cut acroſs, and yet for a whole night and a day its heart does not ceaſe beating, and continues obedient to ſtimuli for a ſtill longer time. It ſeems as if nothing but the loſs of organization could make this irritable muſcle ceaſe to act; or rather it ſeems as if even ſome degree of deranged organization could be reſtored: breathe upon a heart which has ceaſed to act, and even that gentle degree of heat and moiſture will reſtore its action. Dr. Gardiner having left a turtle's heart neglected in a handkerchief, he found it quite dry and ſhrivelled, but by ſoaking it in tepid water its plumpneſs and contractility were reſtored.

Since then this irritable power ſupports itſelf in parts long after they are ſevered from the body, what doubt ſhould we have that there is in the muſcular fibre ſome innate contractile power or vis inſita independent of nerves? And when we talk on a ſubject ſo difficult and ſo abſtruſe, what other proof can we expect or wiſh for than the power of one peculiar and inſulated muſcle ſurviving the ſeparation of the head and brain, the deſtruction of its nerves, or its total ſeparation from that living ſyſtem to which it belongs? If the heart be the moſt irritable muſcle of the body, if all this irritability ariſe from the nerves, how can it be that this muſcle, which is thus announced as the moſt dependent on its nerves, is really the moſt independent? that the muſcle

 which

which of all the body needs this nervous ſupply ofteneſt ſhould want it the leaſt, and ſhould ſurvive the loſs of its nerves ſo much longer than the other muſcles of the ſame body?

Although the ancients knew how irritable the heart was, although they often opened living creatures, and ſaw the heart ſtruggling to relieve itſelf, becauſe it was oppreſſed with blood, yet they continued entirely ignorant of the cauſe: and why the heart ſhould alternately contract and relax without ſtop or interruption, ſeemed to them the moſt inexplicable thing in nature. Hippocrates aſcribed it to the innate fire that is in the heart; Sylvius ſaid, that the old and alkaline blood in the heart mixing with the new and acid chyle, and with the pancreatic lymph, produced a ferment there; Swammerdam, Pitcairn, and Friend, thought that the heart, and every muſcle which had no antagoniſt muſcle, was moved by a leſs proportion of the vital ſpirit than other muſcles required. Others believed that each contraction of a muſcle compreſſed the nerves of that muſcle, and each relaxation relieved it; and that this alternate compreſſion and relief of the nerve was the cauſe of the alternate movements of the heart: another phyſician of our own country, a great mechanic and a profound ſcholar in mathematics, and all thoſe parts of ſcience which have nothing to do with the philoſophy of the human body, refined upon this theory moſt elegantly; for obſerving that the nerves of the heart turned round the aorta, and paſſed down betwixt it and the pulmonic artery, he explained the matter thus: "Theſe great arteries, every time they are full, will compreſs the nerves of the heart, and ſo ſtop this nervous fluid, and every time they are emptied (a thing which he choſe to take for granted, for in truth they never are emptied), they muſt leave the nerves free, and let the nervous fluid paſs down to move the heart."

Des Cartes, who ſtudied every thing like a right philoſopher of the old breed, viz. by conjecture alone, ſuppoſed that a ſmall quantity of blood remained in the ventricle after each ſtroke of the heart; which drop of

blood

blood fermented, became a ſort of leaven, and operated upon the next blood that came into the heart " like vitriol upon tartar;" ſo that every ſucceſſive drop of blood which fell into the ventricle ſwelled and puffed up ſo ſuddenly as to diſtend the heart, and then burſt out by the aorta. Philoſophers have been ſo bewitched with the deſire of explaining the phenomena of the human body, but without diligence enough to ſtudy its ſtructure, that from Ariſtotle to Buffon, it is all the ſame, great ignorance and great preſumption. But on this ſubject of the pulſe of the heart, phyſicians almoſt ſurpaſſed the philoſophers in the abſurdity of their theories, till at laſt they were reduced to the ſad dilemma of either giving up ſpeaking upon this favourite ſubject, or of contenting themſelves with ſaying, " that the heart beat by its facultas pulſifica, its pulſative faculty;" as if they had ſaid, the jaws chew by their mandicative faculty, and the bladder piſſes by its expulſive faculty, and the womb expels children by its parturient power.

The ancients, I have ſaid, often opened living creatures, and ſaw the heart ſtruggling to relieve itſelf becauſe it was oppreſſed with blood: this blood is itſelf the ſtimulus which moves the whole; for important as this function is, it is equally ſimple with all the others: and as urine is the ſtimulus to the bladder, food an excitement to the inteſtines, and the full grown fœtus a ſtimulus to the womb!—ſo is blood the true ſtimulus to the heart. When the blood ruſhes into the heart, the heart is excited and acts; when it has expelled that blood, it lies quieſcent for a time; when blood ruſhes in anew, it is rouſed again: ſo natural is both the inceſſant action and regular alternation of contraction and relaxation in the heart.

It is when we are ſo cruel as to open a living creature that we ſee beſt both the operation of the blood as a ſtimulus, and the manner in which the heart re-acts upon it. When we tie the two vena cavas ſo as to prevent the blood from arriving at the heart, the heart ſtops; when we ſlacken our ligatures and let in the blood, it moves again; when we tie the aorta, the left

ventricle

ventricle being full of blood will continue ſtruggling, bending, turning up its apex, and contracting inceſſantly and ſtrongly, and will continue this ſtruggle long after the other parts have loſt their powers. One author, whether from his awkwardneſs, or the delicacy of the ſubject, or really from the ſtrength of the ventricle, aſſures us, that often while he has held the aorta of a Frog cloſe with pincers, it has burſt by the mere force of the heart. If, after violent ſtruggles of this kind, you cut the aorta, even of ſo ſmall a creature as an Eel, it will throw its blood to the diſtance of three or four inches.

Thus we not only know that we can excite the heart by accumulating blood in it, but that by confining the blood in it we can carry that excitement to a very high degree; and in ſhort, by keeping the one or the other ventricle inceſſantly full of blood, we can make the one heart work continually, while the other lies quiet, or is only ſlightly drawn by the other's motion, ſhowing the true diſtinction betwixt the heart of the body, and the heart of the lungs. And this is a memorable fact, that it is not merely the ſtimulus of the blood, but the ſenſe of fulneſs that makes the heart contract; for the auricle often beats twice or thrice, ſometimes it makes its puſh four or five times, before it can force the ventricle to contract.

When we empty the heart, and tie all its veins, all its parts ceaſe to act; ſtimuli applied outwardly make it contract partially; it trembles in particular fibres: but it is only letting in the blood, or blowing it up with air, that can bring it into full action again. When we look with cruel deliberation upon the ſtrokes of the heart in any living creature, we obſerve that at firſt, during the full and rapid action of the heart, there is hardly any perceptible interval among the ſeveral parts; but towards the end of each experiment, when the pulſe flags, and the creature falls low, the ſwelling of the great veins, and the ſucceſſive ſtrokes of auricle and ventricle, are diſtinctly told. The dilatation and contraction of each part is what we cannot

not obſerve, they are ſo quick; but theſe things we diſtinctly obſerve: The auricle contracts and dilates the ventricle; the ventricle contracts, ſubſides, and fills the aorta; the aorta turns and twiſts with the force of the blood driven into it, and by its own re-action, and the ventricle, every time that it contracts, aſſumes a form ſlightly curved, the point turning up like a tongue towards the baſis, and the baſis in ſome degree bending towards the point. The baſis, indeed, is in ſome degree fixed to the diaphragm and ſpine, but the heart in its contraction always moves upon its baſis as upon a centre; its ventricles, and eſpecially its apex, are free; the point riſes and curves ſo as to ſtrike againſt the ribs; and the dilatation of the heart is ſuch (together with the poſture and relation of its ſeveral parts), that during the dilatation the heart turns upon its axis one way; the contraction of the heart reverſes this, and makes it turn the other way, ſo that it ſeems to work perpetually with the turning motions of a ſcrew. All this is moſt ſtriking, while we are looking upon the motion of the heart in a living creature.

The poſture of the human heart is very ſingular, and will illuſtrate this turning motion extremely well; for in the human heart the poſture is ſo diſtorted, that no one part has that relation to another which we ſhould beforehand expect. In the general ſyſtem, the human heart is placed nearly in the centre, but not for thoſe reaſons which Dionis has aſſigned; it is not in order that by being in the centre it may feel leſs the difficulty of driving the blood to any particular limb or part of the body; it is the place of the lungs that regulates the poſture of the heart; and wherever they are, it is. Except the Oyſter, I hardly know of any creature in which the heart lies expreſsly in the centre of the body. In Frogs, Toads, Newts, and Snakes, the lungs are not moved by any diaphragm; they are filled only by the working of the bag attached to the lower jaw, the ungs then begin under the jaws, and the heart is lodged at the root of the jaws, leaving, as in a Newt

or Cameleon, Crocodile, Adder, Serpent, &c. the whole length of their trailing body behind. In a fifh, the gills ferve the creature for lungs; the gills are lodged under the jaws, and the heart is placed betwixt them. In infects, as in the common Caterpillar (the aurelia of our common Butterfly), the air enters by many pores on its fides; and accordingly its heart is not a fmall round bag, but may be eafily feen running all down its back, working like a long aorta, but having regular pulfations, denoting it to be the heart; and this you eafily fee through the infect's fkin, for it is more tranfparent along the back where the heart is.

The breaft in man is divided into two cavities by a membrane named the MEDIASTINUM. This membrane paffes directly acrofs the breaft from the fternum before, till it fixes itfelf into the fpine behind. It is on the left fide of this membrane, in the left cavity of the breaft, that the heart is placed, lying out flat upon the diaphragm, as upon a floor, by which it is fupported *; and that furface (*a*)—which lies thus upon the diaphragm, is perfectly flat, while the upper furface (*b*)—or what we ufually call the fore-part of the heart, is remarkably round. The whole heart lies out flat upon the diaphragm; its bafis (*c*)—where the auricles are, is turned towards the fpine and towards the right fide; the apex (*d*)—or acute point, is turned forwards, and a little obliquely towards the left fide, where it ftrikes the ribs; the vena cava (*e*)—enters in fuch a manner through a tendinous ring of the diaphragm †, that it ties down the right auricle to that floor (as I may term it) of the thorax; the aorta (*f*) does not rife in that towering fafhion in which it is feen

* The true pofition of the heart is what is reprefented in N° 16, and 17.; where N° 16. fhows the heart fet upright, as I have hitherto reprefented it in all my plans, while N° 17. reprefents its inclined pofition lying almoft horizontally upon the floor of the diaphragm.

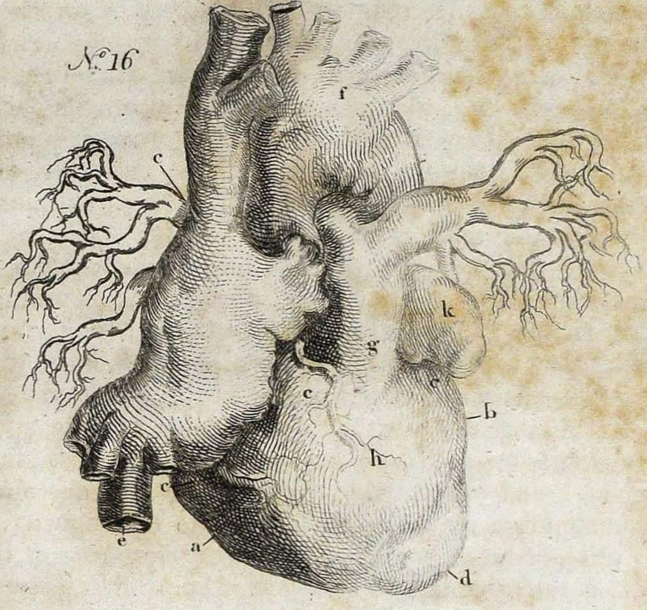
† Let it be obferved, that (*e*) in this drawing marks the point where the lower cava was tied clofe upon the diaphragm, to prevent the injection going down into the veins of the liver and abdominal cavæ.

when

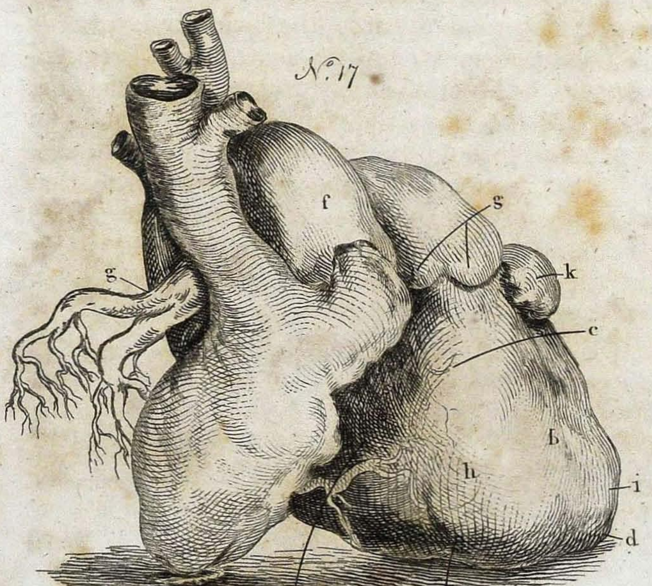
Sketches

demonstrating the true position of the Heart.

N.° 16



N.° 17



when we take a dried-up heart, which naturally we hold by its apex, inſtead of laying it out flat upon the palm of our hand; nor in that perpendicular direction in which hitherto, for the ſake of diſtinctneſs, I have repreſented it in theſe plans; but the aorta goes out from its ventricle towards the right ſide of the thorax; it then turns in form of an arch, not directly upwards, but rather backwards towards the ſpine; then it makes a third twiſt to turn downwards; where it turns downwards it hooks round the pulmonic artery (*g*),—juſt as we hook the fore-fingers of our two hands within one another. The right heart (*hh*)—ſtands ſo before the other, that we ſee chiefly the right auricle and ventricle before, ſo that it might be named the anterior heart; the pulmonic artery (*g*)—covers the root of the aorta; the left ventricle (*i*),—from which the aorta riſes, ſhows little more than its point at the apex of the heart; the left auricle (*k*)—is ſeen only in its very tip or extremity, where it lies juſt behind the pulmonic artery; and the aorta (*f*)—ariſes from the very centre of the heart. From this view any man may underſtand theſe veſſels by other marks than the mere colours of an injection; and he will alſo eaſily underſtand why the heart twiſts ſo in its actions, and how it comes to paſs that its poſture is difficult for us to conceive, no one part having that relation to any other part which we ſhould beforehand ſuppoſe.

Of the Pericardium.

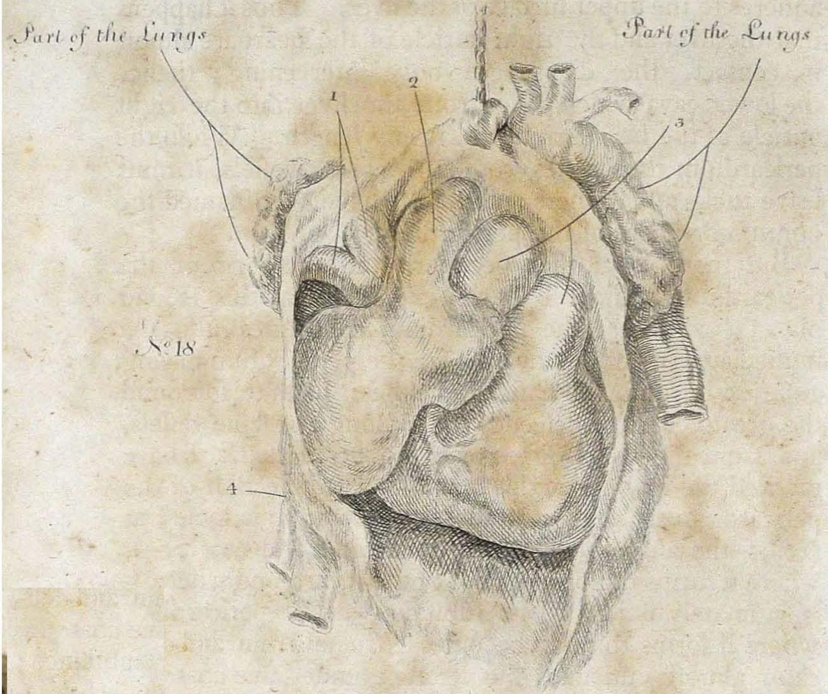
But the PERICARDIUM, purſe, or capſule, in which the heart is contained, affects and regulates its poſture, and makes the laſt important point concerning the anatomy of the heart. It is a bag of conſiderable ſize and great ſtrength, which ſeems to us to go very looſely round the heart, becauſe when we open the pericardium the heart is quite empty and relaxed; but I believe it to ſurround the heart ſo cloſely as to ſupport

ſupport it in its palpitations, and more violent and irregular actions; for when we inject the heart, its pericardium remaining entire, that bag is filled ſo full that we can hardly lay it open with a probe and lancet without wounding the heart; and ſtill further, when we open the pericardium before we inject the heart, the heart receives much more injection, ſwells to an unnatural bulk for the thorax that it is contained in, and loſes its right ſhape. The pericardium is formed like the pleura and mediaſtinum, of the cellular ſubſtance; it is rough and irregular without, and fleecy with the threads of cellular ſubſtance, by which it is connected with all the ſurrounding parts; within it is ſmooth, white, tendinous, and gliſtening; and exceedingly ſtrong. As the heart lies upon the floor of the diaphragm, the pericardium, which lies under the heart, is connected with the diaphragm a little to the left of its tendinous centre, and ſo very ſtrongly that they are abſolutely inſeparable. The pericardium ſurrounds the whole heart, but it is looſe every where except at the root of the heart, where it is connected with the great veſſels: For the pericardium is not fixed into the heart itſelf, but riſes a conſiderable way upon the great veſſels, and gives to the roots of the veſſels, which are ſeen on opening the pericardium, an outward coat, and ſurrounds each veſſel with a ſort of ring, as may be ſeen in the plan *. For, 1ſt, It ſurrounds the pulmonic veins where they are entering the heart; there the pericardium is ſhort: 2dly, It mounts higher upon the vena cava than upon any other veſſel; the cava of courſe is longer within the pericardium, and it alſo is ſurrounded with a ſort of ring: 3dly, It then paſſes round the aorta and pulmonic artery, ſurrounding theſe in one greater loop: 4thly, The cava inferior is the veſſel which is the ſhorteſt within the pericardium: for the heart inclines towards the horizontal direction: it lies in a manner flat upon the upper ſurface of the diaphragm, while the lower ſurface of the diaphragm

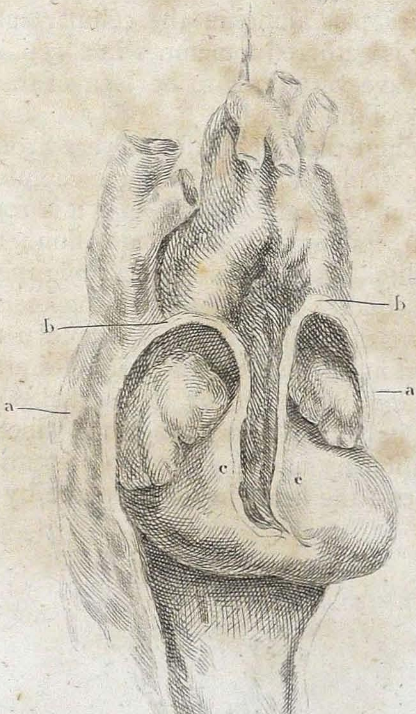
* Vide Plan, N° 18.

adheres

Sketches
of the Pericardium of which No. 18 is a true drawing No. 19 a Plan shewing its inflexion over the Heart



No. 18



No. 19

adheres to the upper ſurface of the liver. Thus it happens that the liver and the right auricle of the heart are almoſt in contact, the diaphragm only intervening; thence the lower cava which paſſes from the liver into the right auricle of the heart cannot have any length. While the pericardium thus paſſes round the great veſſels, it muſt leave tucks and corners; and theſe have been named the CORNUA or horns of the pericardium.

But there is another peculiarity in the form of the pericardium, which I have explained in this ſecond plan *; viz. that the pericardium conſtitutes alſo the immediate coat of the heart; for the pericardium having gone up beyond the baſis of the heart ſo as to ſurround the great veſſels, it deſcends again along the ſame veſſels, and from the veſſels goes over the heart itſelf. I have marked the manner of this more delicate inflection of the pericardium at (*aa*),—where the pericardium is looſe; at (*bb*),—the angle where it is reflected; and at (*cc*)—, where it forms the proper coat of the heart, and where it is intimately united to its ſubſtance The pericardium where it forms this coat becomes extremely thin and delicate, almoſt cuticular, but ſtrong; under this coat the coronary arteries paſs along in the cellular ſubſtance; under it the fat is gathered ſometimes in a wonderful degree, ſo as to leave very little to be ſeen of the dark or muſcular colour of the heart.

The pericardium then is a denſe and very ſtrong membrane, which I would compare with the capſule of any great joint, both in office and in form: for it is rough and cellular without, ſhining and tendinous within; bedewed with a ſort of halitus like the great joints, though perfect yet delicate in the child, but increaſing in thickneſs by the continual frictions of the heart, juſt as a capſular ligament does by the working of its joint; and its uſes are to keep the heart eaſy and lubricated by that exhalation which proceeds from its exhalent arteries (and which can be imitated ſo eaſily by injecting tepid water into its arteries) to ſuſpend the heart in ſome degree by its con-

* Nº 19.

nections with other parts, especially by its connections with the mediastinum and diaphragm. The pericardium limits the distention of the heart, and checks its too violent actions; just as we see it prevent too much of our injections from entering the heart. How strong the pericardium is, and how capable of supporting the action of the heart, even after the most terrible accidents, we know from this; that the heart or coronary arteries have actually burst, but with a hole so small as not to occasion immediate loss of life; then the pericardium receiving the blood which came from the rupture, has dilated in such a manner as to receive nine or ten pounds of blood, but has yielded so slowly as to support the heart in some kind of action, and so preserved life for two or three days.

If I have not mentioned any fluid under the direct name of AQUA PERICARDII, or the water of the pericardium, it is because I consider the accident of water being found as belonging not to the healthy structure but to disease. Yet this same water occupied the attention of the older authors in a most ludicrous degree. Hippocrates believed that this water of the pericardium came chiefly from the drink we swallow, which found some way or other (as it passed by the pericardium) to insinuate itself into this bag: Some after him said, it was the fat of the heart melted down by incessant motion and the heat of the heart; some said it was from humours exuding through the heart itself, and retained by the density of the pericardium that this water came; and it is but a few years since this clear and distinct account of it was given, viz. "that it proceeds from the aqueous excrementitious humour of the third concoction." The same "sad and learned men *, viri graves et docti," declare to us, that the uses of the aqua pericardii are to cool the heart, for it is the very hottest thing in the body; or by its acrimony to irritate the heart, and

* They are thus denominated in all the charters of the College of Physicians from the time of Henry VIII. downwards.

support

ſupport its motions; or to make the heart by ſwimming in it ſeem lighter. By this it is pretty obvious what abſurd notions they had of the quantity of water that may be found in the heart. But of all the outrages againſt common ſenſe and common decorum, the moſt ſingular was the diſpute maintained among them, whether it was or was not the water of the pericardium which ruſhed out when our Saviour's ſide was pierced with the ſpear? The celebrated Bardius, in a learned letter to Bartholine, ſhows how it was the water of the pericardium that flowed out; but Bartholine, in his replication thereunto, demonſtrates, that it muſt have been the water of the pleura alone. This abominable and ludicrous queſtion, I ſay, they bandied about like boys rather than men; Bartholinus, Arius, Montanus, Bertinus Nicelius, Fardovius, Laurenbergius, Chiprianus, with numberleſs other Doctors and Saints, were all buſy in the diſpute; for which they muſt have been burnt every ſoul of them, at the ſtake, had they done this in ridicule; but they proceeded in this matter with the moſt ſerious intentions in the world, and with the utmoſt gravity *. The whole truth concerning water in the pericardium is, that you find water there whenever at any time you find it in any of the other cavities of the body. If a perſon have laboured under a continued weakneſs, or have been

* The ſhocking indecencies of their reaſonings on this ſubject I will not condeſcend to draw out from the obſcurity of that barbarous idiom in which it was delivered: "Sed non cogar huc me conferre. Fateor enim nativam Chriſti temperiem nihil pravorum humorum produxiſſe, quia perfectiſſima; at a cauſis externis, vigiliis, cruciatibus, itineribus, vulneribus et mille tormentis quid non præter conſuetam naturæ divinæ perfectionem productum credimus? Ad hæc ſano ſenſu id accipiendum, nihil pravorum humorum in corpore Chriſti generatum." *Bartholini Epiſtolæ*, p. 299.—"Idque de Salvatore innoxie dixeris, quem ſcimus manducaſſe, bibiſſe, dormiviſſe, ambulaſſe et quid non egiſſe, ut ſe hominem cunctis actionibus, quæ ſecundum naturam ſunt, ſubmitteret: ſputum emiſit, quum luto miſceret ad curandum cæcum, et ſudavit ingruente martyrio, et ſine dubio non parum ſeri in thorace collegit, quod, aperto poſt mortem latere, emanavit." *Barthplini Epiſtolæ*, p. 300.

 long

long diseased, if a person have lain long on his death-bed, if the body have been long kept after death, there is both a condensation of the natural halitus in all the parts of the body, and an exudation of thin lymph from every vessel; there is water found in every cavity, from the ventricles of the brain to the cavity of the ankle joint, and so in the pericardium among the rest. But if you open any living animal, as a Dog, or if you open suddenly the body of a suicide, or a criminal who has been just hanged, not a drop of water will be found in the pericardium. When such fluid is to be found, it is of the same nature with the dropsical fluids of other cavities: in the child, and in young people, it is reddish, especially if the pericardium be inflamed; in older people it is pellucid, or of a light straw colour; in old age and in the larger animals it is thicker, and more directly resembles the liquor of a joint.

Thus does the pericardium contribute in some degree to settle the posture of the heart; but still the heart is to a certain degree loose and free. It is fixed by nothing but its great vessels as they run up towards the neck, or are connected with the spine; but how slight this hold is, how much the heart must be moved, and these vessels endangered, by shocks and falls, it is awful to think. The pericardium is no doubt some restraint; its connections with the diaphragm and with the mediastinum, make it a provision, in some degree, against any violent shock; its internal lubricity is, at the same time, a means of making the heart's motions more free: yet the heart rolls about in the thorax; we turn to our left side in bed, and it beats there; we turn over to our right side, and the heart falls back into the chest, so that its pulse is no where to be perceived; we incline to our left side again, and it beats quick and strong. The heart is raised by a full stomach, and is pushed upwards in dropsy; and during pregnancy its posture is remarkably changed; it is suddenly depressed again when the child is delivered, or the waters of a dropsy drawn off. It is shaken by

by coughing, laughing, ſneezing, and every violent effort of the thorax. By matter collected within the thorax it may be diſplaced to any degree. Dr. Farquharſon cured a fine boy, about eight years old, of a great collection of matter in the cheſt, whoſe heart was ſo diſplaced by a vaſt quantity (no leſs than four pounds) of pus, that it beat ſtrongly on the right ſide of the breaſt while his diſeaſe continued, and as ſoon as the pus was evacuated, the beating of the heart returned naturally to the left ſide. Who could have believed that, without material injury, the heart could be ſo long and ſo violently diſplaced? Felix Platerus tells us a thing not ſo eaſily believed, that a young boy, the ſon of a printer, having practiſed too much that trick which boys have of going upon their hands with their head to the ground, began to feel terrible palpitations in the left breaſt; theſe gradually increaſed till he fell into a dropſy from weakneſs, and died; and upon diſſecting his body, the ſituation of his heart was found to have been remarkably changed by this irregular poſture. Now we are not to argue that ſuch change of poſture of the heart could not happen merely from this cauſe, becauſe profeſſed tumblers have not theſe diſeaſes of the heart; it were as ſilly to argue thus againſt the authority of Platerus, as to ſay that every poſt-boy has not aneuriſms of the ham, or that every chimney-ſweep has not a cancer of the ſcrotum.

We may now cloſe this chapter on the mechaniſm of the heart; in which all the parts have been ſucceſſively explained. We know how the heart is ſuſpended by the mediaſtinum, and by its great veſſels; how it is lubricated, ſupported, and regulated in its motions, by the pericardium; its nerves, which remain to be explained at a fitter time, are extremely ſmall, while its vis inſita, or irritability, is great beyond that of all the other parts. We can eaſily follow the circle of the blood, which, as it arrives from all the extremities, irritates the auricle, is driven down into the ventricle, is forced thence into the pulmonic artery, pervades the

 lungs,

lungs, and then comes round to the left ſide of the heart, or to that heart which ſupplies the body; and there begins a new circulation, called the greater circulation, viz. of the body, as the other is called the leſſer circulation of the lungs. Thus we recogniſe diſtinctly the functions of the double heart, with all its mechaniſm; the ſtronger heart to ſerve the body, the weaker heart to ſerve the lungs; and we ſee in the plaineſt manner two diſtinct functions performed by one compound heart: the right heart circulates the blood in the lungs, where it is purified and renewed; the left delivers out a quantity of blood, not ſuch as to fill all the veſſels, nor ſuch as to move onwards by this ſingle ſtroke of the heart to the very extremities of the body, but ſuch merely as to give a ſenſe of fulneſs and tenſion to the veſſels: the force is merely ſuch as to excite and ſupport that action which the arteries every where perform in the various organs of the body, each artery for its appropriated purpoſes, and each in its peculiar degree.

By underſtanding thus the true mechaniſm and uſes of the heart, we can conceive how the ancients were led into ſtrange miſtakes, by very ſimple and natural appearances. We underſtand why Galen called the right auricle the "ultimum moriens," or the part which died laſt; for, upon opening the body ſoon after death, he found the right auricle filled with blood, and ſtill palpitating with the remains of life, when all the other parts ſeemed abſolutely dead; and if the blood always accumulates on the right ſide of the heart before death, it is plain that the ſtimulus of that blood will preſerve the remains of life in the right ſide, after all appearance of life on the left ſide is gone. But the cauſe of this accumulation of blood in the right ſide is very ill explained by Haller, though it ſeems to have employed his thoughts during half his life. He ſays, that in our laſt moments we breathe with difficulty; the lungs at laſt collapſe, and ceaſe to act; and when they are collapſed, no blood can paſs through them, but muſt accumulate in the right ſide of the heart.

That

That there is really no ſuch collapſe of the lungs, I propoſe hereafter to ſhow; but, in the meanwhile, this is the true reaſon, viz. that when the ventricles of the heart ceaſe to act, and the beating of the heart ſubſides, the two auricles lie equally quiet, but in very different conditions; the right auricle has behind it all the blood of the body pouring in from all parts during the laſt ſtruggles; but the left auricle has behind it nothing but the empty veins of the lungs; nothing can fill it but what fills the veſſels of the lungs; or, in other terms, nothing can fill the left auricle but the ſtroke of the heart itſelf: but inſtead of acting the heart falls into a quieſcent ſtate, the left auricle remains empty, while the blood oozes into the right auricle from all the extremities of the body till it fills it up.

Nothing is more agreeable than to find ſuch phenomena deſcribed faithfully long before the reaſon of them is underſtood. In the Pariſian diſſections I find the following deſcription: "When the breaſt of a living Dog is opened by taking away the ſternum, with the cartilaginous appendices of the ribs, the lungs are obſerved ſuddenly to ſink, and afterwards the circulation of the blood and the motion of the heart to ceaſe. In a little time after that the right ventricle of the heart and the vena cava are ſwelled, as if they were ready to burſt *." This was what deceived the ancients, and was the cauſe of all their miſtakes. When they found the right ventricle thus full of blood, they conceived that it alone conveyed the blood; they found the left ventricle empty, and believed that it contained nothing but vital ſpirits and air; and ſo far were they from having any notions of a circulation, that they thought the air and vital ſpirits went continually forwards in the arteries; that the groſs blood which was prepared in the liver came up to the heart to be perfected, and went continually forwards in the veins, or, if they provided any way of return for theſe two fluids,

* Page 261.

it was by ſuppoſing that the blood and ſpirits moved forwards during the day-time, and backwards in the ſame veſſels during the night.

Theſe things next explain to us why they called the right ventricle VENTRICULUS SANGUINEUS: they found it full of blood, and thought its walls were thinner, becauſe it had only to contain the very groſſeſt parts of the blood: and why they called the left ventricle VENTRICULUS SPIRITUOSUS and NOBILIS becauſe they ſaw it empty, and concluded that it contained the animal ſpirits and aërial parts of the blood, and its walls were thicker, they ſaid, to contain theſe ſubtile ſpirits. They explain to us their names of ARTERIA VENOSA and VENA ARTERIOSA; for they would have veins only on the right ſide of the heart, and arteries only on the left; and although they ſaw plainly that the pulmonic artery was an artery, they called it Arteria Venoſa: and although, on the left ſide again, they ſaw plainly that the pulmonic vein was merely a vein, they would ſtill cheat themſelves with a name, and call it Vena Arterioſa: the veins, they ſaid, were quiet, becauſe they contained nothing but mere blood; the arteries leaped, they ſaid, becauſe they were full of the animal ſpirits and vital air.

The very name and diſtinction of arteries which we now uſe, ariſe from this fooliſh doctrine about air and animal ſpirits. To the oldeſt phyſicians there was no veſſel known by the name of artery, except the ASPERA ARTERIA; and it was named Artery becauſe it contained air; ſo that Hippocrates, when he ſpeaks of the carotids, never names them arteries, but calls them the Leaping Veins of the neck. But when Eriſtratus had eſtabliſhed his doctrine about the veſſels which go out from the heart, carrying vital ſpirits and air, the name of artery was transferred to them; and then it was that the ancients began to call the veſſels going out from the left ſide of the heart, arteries, naming the aorta the ARTERIA MAGNA and the pulmonic vein the ARTERIA VENOSA.

When a vein was cut, they ſaw nothing but groſs blood, and of a darker colour; but when an artery was

cut,

cut, they obſerved that the blood was red; that it was full of air bubbles; that it ſpurted out, and was full of animal ſpirits; and thus it became eaſy for them to ſhow how ſafe it was to open a vein where nothing was loſt but groſs blood, how terribly dangerous it was to open an artery which was beating with the ſpirit of life; and this they conſidered as ſuch an awful difference, that when arteriotomy in the temple was firſt propoſed, they pronounced it murderous, and on this reaſoning it was abſolutely forſaken for many ages.

But the oldeſt of our modern phyſicians ſoon found a neceſſity of mixing this blood and animal ſpirits together, and for a long while could hit on no convenient way by which this mixture might be effected: as a laſt ſhift, they made the blood exude through the ſeptum of the heart; and then the current doctrine was, that of the blood which came from the liver, one half went into the pulmonic artery to nouriſh the lungs; the other half exuded through the ſeptum of the heart, to mix with the animal ſpirits. Riolanus was the bitter enemy of Harvey and of his noble doctrine; and this is the miſerable and confuſed notion, not to call it a doctrine, which he trumpeted through Europe in letters and pamphlets. To make good this miſerable hypotheſis, Riolanus, Gaſſendus, and many others, ſaw the neceſſity of having ſide paſſages through the ſeptum of the heart. I really believe from their mean equivocating manner of talking about theſe paſſages, that they had never believed them themſelves *. "The chyle," ſays Bartholine, "and the thinner blood, paſſes through the ſeptum of the heart, when the heart is in ſyſtole and the pores and paſſages are enlarged." Thus did the celebrated Bartholine believe the ſeptum perforated. Wallæus, and Marchetti, and Mollinettus, and Monichen, believed it, and Mr. Broadbecquius of Tubingen proved it †. But I

* That I may not ſeem to ſpeak too harſhly of this knot of conſpirators againſt Harvey, I will quote what Boerhaave ſays of Riolanus, who was at the head of them; "Non ipſe callidus cavillationum artifex Riolanus," &c.

† Experimento perforatum oſtendit Broadbecquius Tubingæ.

believe moſt potently with Haller, that whenever they wanted to ſhow thoſe perforations, they managed their probes ſo as to make paſſages as wide and as frequent as the occaſion required: " Solebant foramina parare adigendo ſtylos argenteos in reſiſtens ſeptum," ſays Haller; and this is a full and true account of all the authors who have deſcribed ſide paſſages through the ſeptum of the heart: they needed them, and they made them.

Amidſt all this ignorance, we cannot wonder that a thouſand childiſh imaginations prevailed, nor that the qualities of the mind were deduced from the phyſical properties of the heart. We have heard the vulgar, for example, ſpeak of the bone of the heart. And from whom did this ariſe? From Ariſtotle! who explains to us, that there is at the root of the heart a bone which ſerves for its baſis; and not a phyſician has written upon the heart ſince his time, who has not ſpoken more or leſs myſteriouſly about this bone; while in truth the whole ſtory means nothing more than this, that where the baſis of the arteries are fixed into the hard ring or baſis of the heart, the place is extremely firm, almoſt cartilaginous, eſpecially in old age, when often the roots of the arteries are oſſified or converted into what anatomiſts have choſen to call bone.

Often alſo we have heard the vulgar talk, not figuratively, but in the plain ſenſe of the words, of a little or big heart, as ſynonymous with a timorous or courageous heart. But whenever we hear miſtakes of this kind among the vulgar, we may be aſſured they have ſome time or other come from high authority. Bartholine was ſo much convinced that a ſmall heart begot courage, and a great one irreſolution and fear, that he is thoroughly ſurpriſed when he finds the contrary; " Cor vaſtus fuit homo, tamen audax fuerat, ut cicatrices in capite frequentes et rimæ in cranio teſtabantur." But if Bartholine be right, Kirkringius is quite wrong, and has miſtaken the doctrine; for he ſays, " An magnanima fuerit hæc magni cordis fœmina, neſcio," &c. " I do not know whether this woman's courage was as big as her heart; but this

this I do know, that ſhe was a famous toper. Whether this drinking dilates the heart, and makes your ſtaunch drinkers ſuch famous fighters, I cannot pretend to decide." We have heard the vulgar talk alſo of a hairy heart, as familiarly as of a hairy man, being the mark of high courage and ſtrength; but what ſhall we think of it, when we find that this report is to be deduced fairly from Pliny, through the moſt celebrated names among our old phyſicians? He it was who began with telling how the Meſſenians, that unhappy people who lived for ſo many ages the ſlaves or helots of Greece, loſt their great general Ariſtomenes. But how great he was, never, according to Pliny, came to be known till after his death; for the Lacedemonians having catched him three times, reſolved at laſt to open his breaſt; and there, as a proof of his moſt invincible courage and daring, they found his heart filled with hair. This from Pliny was nothing, if ſuch diſſections had not been made ſince then a hundred times. "There was a robber (ſays Benivinius), one Jacobus, who having been taken down from the gibbet apparently dead, but really having in him the remains of life, was laid carefully, recovered, was perfectly reſtored, betook himſelf to his old ways again; and ſo in the natural courſe of things came round to his old mark the gallows, and was this time very thoroughly hanged. Wondering (ſays Benivinius) at the perfect wickedneſs of this man, I longed very anxiouſly to diſſect the body, and I actually found the heart, not covered, but (refertum pilis) crammed with hair."

But there is, in fact, no end of wonders and wonderful diſſections among theſe robbers of his. His next ſubject was not a bold robber, but a poor ſneaking thief (de corde furis cujuſdam); there was no hair to be expected in his heart; but as he was a thief only, it was conſiſtent with this doctrine that he ſhould be firſt very heartleſs; ſecondly, have very little brain; thirdly, that he ſhould have very inordinate appetites and deſires. Now there was firſt a great two-legged vein carrying the atrabilis, the ſource, no doubt, of all his inordinate cravings,

cravings, directly into the ſtomach. Secondly, there was a great abſceſs full of pus waſting the left ſide of his heart; and, thirdly and laſtly, the back part of the head (which all the anatomiſts of that time knew very well was the ſeat of memory) was in him ſo ſmall that it could hardly contain a ſpoonful of that kind of brain; and this want was the reaſon (having ſo little memory) that he was ſo perſevering a thief; for let you whip him, baniſh him, clap him in the ſtocks, he forgot it ſtraightway, and was back at his old tricks again, like a dog to his vomit *."

But theſe are now almoſt forgotten, though perhaps the hiſtory of the abſurdities of the human genius ſhould no more be neglected than of its beauties. Is it not delightful to feel, that after floating in this ocean of conjecture, after all theſe diſorderly and wild dreams, we are come to have an idea of the heart, ſimple and beautiful; of a heart containing within itſelf two functions; firſt, the office of renewing the blood; ſecondly, the office of animating the arteries, and by them preſerving in life and action the whole ſyſtem of the body? Theſe are the two offices which I ſhall now proceed to explain.

* "Non videntur ſilentio eſſe prætereunda, quæ nuper in inciſo Jacobi cujuſdam furis inſignis cadavere annotavimus: bifurcatam ſcilicet venam quæ a liene ad ventriculum atram defert bilem, tum et abſceſſum in ſiniſtro cordis ventre pituita redundantem: poſtremo et poſteriorem ejus capitis partem, ubi memoriæ ſedes eſt, adeo brevem, ut tantillam cerebri portiunculam contineret. Quam ob cauſam, cum priorum ſcelerum et eorum quæ pro his ſæpe paſſus fuerat, tormenta ſcilicet, exilia et carceres minime recordaretur, toties ad vomitum tanquam canis impudens reverſus eſt, ut in laqueum tandem inciderit, vitæque ac furti finem fecerit."—Vid. *Benevinius*.

CHAP.

CHAP. II.

ON THE APPEARANCE AND PROPERTIES OF THE BLOOD, ON THE CHEMISTRY OF OUR FLUIDS, AND ON THE INFLUENCE WHICH AIR HAS UPON THEM.

BY the ſimpleſt methods the blood can be reſolved into various parts, but chiefly into theſe three; the red globules, which give colour to the blood; the gluten, which gives conſiſtency and nutritious qualities to the blood; and the ſerum, which dilutes, mixes, and ſuſpends the whole.

Though the ſerum and gluten did not paſs entirely unnoticed, the red globules were the part of the blood which firſt excited the attention of phyſicians, and ſeemed to promiſe a rich harveſt of diſcoveries; a promiſe which too ſurely never was fulfilled. The red particles have always appeared important, becauſe they ſeem to give the colour, the uſeful qualities, and the whole character to the blood. It is by the rolling of the red particles only that we ſee the circulation in the microſcope; it is red blood only that we ever name as blood; and the colour of the red blood changes in health and diſeaſe. But when phyſicians ſtudied this part alone, when they gave it the mark of chief importance, and annexed to it alone the name of blood, they little thought how far they over-rated its importance, how far the red particles are from nouriſhing the ſyſtem, from being eſſential to the blood, from being univerſal in all creatures. They had not conſidered what myriads of animals, great as well as ſmall, want the red particles, and (if theſe red particles are to be the characteriſtic) want blood; while philoſophers of leſs contracted notions have continued to call that fluid, blood, which fills the veſſels of plants.

The Harveian doctrine had no ſooner produced a revolution in the general doctrines of phyſiology, or phyſicians begun to think of the heart and its circulation, of the great arteries, and extreme veſſels, of the

difference betwixt arteries and veins, and of the ways in which the fluids move through the ſmaller tubes (for they ſaw them moving by their microſcopes); no ſooner did all theſe phenomena and new wonders preſent themſelves to their imaginations, than they thought alſo of curious ways by which theſe motions and ſecretions might be explained. They then began to eſtimate the calibres of the arteries, to calculate with great affectation of care the ſhape, the ſize, the compoſition, as they choſe to call it, of the particles of the blood; chimeras and fancies ſprung up innumerable; and it happened unfortunately that for a long while phyſicians ſtudied nothing but angles, and logarithms, and algebraical equations; they reaſoned according to thoſe ſciences only which have no connection with the phyſiology of the animal body; they calculated the force, the thickneſs, the dimenſions of the heart; the diameter, and the ſtrength of walls, and the direction of the aorta; their experiments conſiſted in fixing clumſy tubes into the arteries, or in calculating the whole quantity of blood by bleeding an animal to death; they applied nothing but the laws of hydraulics, *i. e.* of fluids riſing and falling in rigid tubes, to explain the active arteries of a living body: in ſhort, in explaining the living body they forgot that it was alive. But now the age of infallible proofs and demonſtrations has paſſed over, and the works of Keill, Pitcairn, Borelli, are quite neglected.

This diſordered and miſerable ſtate of ſcience, which continued for a century nearly, aroſe from thoſe red particles of the blood engroſſing too much attention, and from their being allowed an importance which does not belong to them; although one muſt ſtill acknowledge that they are very ſurpriſing, becauſe they are very unaccountable, at leaſt I do not know that any natural or likely uſe for them has been yet aſſigned.

Leeuwenhoek, looking through his glaſſes, ſaw that this which gave the red colour was the moſt permanent characteriſtic part of the blood; he ſaw that this part conſiſted of red particles floating in the ſerum; he found, or pretended to find, that they were of the ſame

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ſize in a man as in a fœtus; in a chick as in a hen; in a whale or elephant, he found them the ſame as in a mouſe or minnow; merely becauſe it was convenient for him to find it ſo.

But poring ſtill longer over theſe particles, he perceived that the great globules were ſo far imperfect as often to break in pieces, and roll about in the ſerum in ſeparate parts; and he always found that there were ſix leſs parts compoſing the greater globule of the blood. By looking more and more, he pretended to obſerve, that theſe ſmaller parts into which the red globules broke down ſtill preſerved their form; that theſe were the particles of the ſerous part of the blood; and that the great or red particles frequently broke down into ſerous particles, and theſe again as frequently united and compoſed afreſh a red globule. He pretended to find, that exactly ſix ſmaller globules went to make up one great one; and he called the red and ſerous globules the globules of the firſt and ſecond order.

By this notion of orders it was plain that he intended to plunge deeper into this hypotheſis, and to have at leaſt a third and fourth order; beſides, theſe orders and particles were at his call, he might do as he pleaſed; and he was almoſt the only perſon poſſeſſed of glaſſes which could enable the phyſiologiſt to ſee and tell about them. He pored till he believed, or at leaſt made others believe, that he ſaw globules of a third order, ſix times ſmaller than the ſerous globules, and of courſe thirty-ſix times ſmaller than the red globules. And thus he had lymphatic particles, ſix of which made up one ſerous particle; and ſerous particles, ſix of which made one red globule.

To the geometrical phyſiologiſts of that day all this inſtruction concerning the ſtructure of the blood was moſt delightful; it correſponded very notably with their calculations about regularly deſcending ſeries of veſſels; and a moſt curious method did they find out for ſettling this law of the branching of arteries. They took the plates of Euſtachius, meaſured with compaſſes the arteries and veins, eſtimated the angles at which each branch

branch goes off, compared the ſeveral branches with the parent trunk; and from ſuch calculations they ſettled the general law as heartily and freely, as if, inſtead of the moſt extravagant plates in all anatomy, they had been meaſuring actually the human body itſelf. Thus they had ſet up their doctrine of angles, branches, anaſtomoſes, trunks, and extreme veſſels: they had found that there was a regular ſeries of deſcending arteries; they had a tube now ſuited to every deſcending particle that Leeuwenhoek could invent; and when a particle had got into a wrong veſſel, it could go back till it found a tube that ſuited it; or if driven into a wrong bore, it could break itſelf down into ſerous or lymphatic particles. But when many particles did ſtick hard in the ſtrait places, then there was an error loci; then the big particles were out of their peculiar veſſels, and then the part began to be red; thence came inflammations, fevers, deeper obſtructions: and from ſuch cauſes, or from the breaking down of the blood and humours, came every diſeaſe that could be named.

So very greatly were they delighted with the diſcovery, that Dr. Martin, who had meaſured the veſſels, as I have juſt told, and had dreamt over this the longeſt and ſoundeſt of them all, ſpeaks of it in theſe rapturous terms. "But we are moreover certain from the obſervations of that moſt accurate and curious obſerver of the minima naturæ, that there are innumerable veſſels of ſuch a ſmallneſs that none of theſe globules could paſs; ſo that it is neceſſary to ſuppoſe inferior claſſes of globules of the fourth, fifth, ſixth, and other orders.— Whence by analogy we are to conceive globules of the third order made up of ſix globules of the fourth order, and theſe of ſix of the fifth order, and ſo on ad infinitum through various degrees, the number of which we are not to take upon us to determine." This is a pleaſant addition of Dr. Martin's; and makes it a moſt manageable ſyſtem of moſt dilatable materials, ſtretching ſo as to ſuit all occaſions. This rider or codicil to the doctrine made it eaſy for every particle to paſs every veſſel; but, alas! it leaves no room for that old catch-

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word of the fyftem, the error loci, nor any provifion for making difeafes.

How all the phyficians in Europe could digeft this abfurdity, of yellow particles, by aggregation and arrangements in fixes and fixes, becoming red, it is not eafy to conceive; nor is it eafy to conceive how men, whofe education in mathematics and algebra fhould have taught them to think accurately and reafon clofely, could believe that globules fhould break down into fix particles each, and that thefe particles, being themfelves particles of ferum, fhould yet be diftinctly feen floating in the ferum. How could thefe geometrical phyficians poffibly believe, that thefe particles, from large to fmall, fhould defcend, not gradually and imperceptibly, but by fixes and fixes, one after another like fteps of ftairs? In all his mathematics, I do not believe that Martin could find any contrivance fit to help him out of thefe difficulties. Martin obferves, in his own way of geometry, and proceeds to prove it by moft laborious fchemes, "that juft fix fmall fphericles fhould go to make up one larger globule, if you were to choofe the moft convenient and firmeft way of conftructing it;" and then he wonders at Leeuwenhoek finding it exactly fo. But if Leeuwenhoek knew this as well as Dr. Martin, I cannot for my heart think it any wonder that Leeuwenhoek chofe "the moft convenient and firmeft way of conftructing a red globule, viz. out of fix fmaller ones." Seeing that he had the affair entirely in his own hands, "what a beautiful HARMONY and REGULARITY do we perceive, fays Martin, in the mafs of blood? Magnum certe opus oculis video." In plain truth, they defired but a little of this harmony, a little confiftency in their doctrine, and all was well.

But the miftakes concerning the formation or organizing of this blood are worfe than thefe; for they came from men truly learned, and diligent in anatomy, led on by too ftrong a defire of finding out the ufes of feveral parts of the human body, as of the fpleen and thymus, parts hitherto unexplained. Mr. Hewfon fuppofed that the lymphatic glands, which feem at firft to be mere convoluted

convoluted veſſels, but which being injected with mercury, and cut into, are ſeen to conſiſt of numerous cells, form in theſe cells the primordia of the red blood; for each red particle he ſuppoſes to conſiſt of a central particle, which is ſolid and dark-coloured, ſurrounded by a veſicle which is tranſparent or white; and this dark or central part he ſuppoſes is formed in the lymphatic cells; for he finds a ſort of round particles in the lymph, and often he finds the lymphatics full of red blood.

Next, he has ſuppoſed that in the child there is required a much greater ſupply of blood; for this purpoſe is the thymus appointed; viz. to aſſiſt the lymphatic glands in organizing blood. This gland lies in the upper part of the cheſt, is great in the child, has vaniſhed in the adult, but while it exiſts, he finds it full of a milky juice or whitiſh mucus, fit to make central particles for the blood; and the lymphatics, as he ſuppoſes, are the excretories for this gland. He next conjectures, that this work, begun thus by the lymphatic glands, and thymus, is perfected by the ſpleen; that the lymphatics make central particles only, while the veſicular coverings are formed in the ſpleen; ſo that there only do the particles become perfect; and accordingly of theſe parts it is in the ſpleen alone that the red blood is found.

As the central particles are formed in the cells of the lymphatic glands, the veſicular parts are formed in the cells of the ſpleen, and the lymphatics unload theſe cells of the particles when completely formed: but there appears no other proof that they do this office than that there are cells in the ſpleen which may make veſicles; and that the lymphatics being tied, and the ſpleen ſqueezed, red globules are ſometimes found in them.

Long poring over a weariſome ſubject, and an intenſe deſire to finiſh that account of the blood which he had ſo ſucceſsfully begun, are ſtrong apologies for all theſe miſtakes. No man will venture to deny, that the glands and lymphatic veſſels probably accompliſh ſome important changes upon all fluids which paſs through them; but that they alone organize the blood, is not to be conceived. Their containing round white particles, argues

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nothing; theſe exiſt in the chyle, and probably in that condition paſs into the blood. But if the fœtus requires a great ſupply of blood, and the thymus aſſiſts the lymphatic glands, how comes it, when both lymphatic glands and thymus are working in concert to prepare a great quantity of blood, that the ſpleen, which is to finiſh all theſe particles, and to make veſicles for them, is not in a child as big as its liver is?

That red globules are found in the lymphatics, and moſt eſpecially in the lymphatics of the ſpleen, is a moſt ordinary occurrence, and quite intelligible. There are not found any where, not even in the ſpleen, imperfect globules advancing in their organization; on the contrary, thoſe which we do find are full formed globules which have been forced out of the common line of the circulation; they are extravaſated, and taken up by the abſorbents before death; or they are ſqueezed into them by handling after death. If we want to have an example of the firſt, we have but to inflame a part and tie up its lymphatics, and then many red particles are found in them; the ſecond we ſee every time we either look for, or prepare the lymphatics of the ſpleen, or of any other ſoft viſcus; for by handling and ſqueezing, the blood paſſes through the ſmall breaches occaſioned by this violence into the lymphatics; if we allow the part to ſpoil, then air is generated, and, by handling it, air paſſes into the lymphatics in the ſame way.

But the ſpleen is eſſential to finiſh the work; it makes the veſicles, and has cells for the buſineſs; and yet this part, which has the moſt important of all offices, viz. that of organizing the general maſs of blood, may be cut out from dogs and other animals, and they never feel the loſs, nor decline in health. There is not the ſmalleſt doubt that the ſpleen has protruded at wounds, and been ſtrangled, and ſo cut off. Every day we find it more or leſs diſeaſed; ſometimes it has ſwelled to thirty or forty pounds; ſometimes it has been reduced to an extremely ſmall ſize; ſometimes it has been found like an empty bag.

In the fœtus, as in a chick for example, red blood circulates in great profusion long before its lymphatics, spleen, or thymus, can be seen to exist; whereas, on the contrary, since the chick is insulated, and has no red blood from the mother, the spleen should have been first coloured, and all the red blood of the system should have emanated from the spleen.

It is but a poor evasion to say, in answer to these objections, "some other part may perform this office of the spleen." What other parts will perform the office of the liver, if it be wanting? or of the kidney, or of the testicle, or of any other gland? or will the testicle secrete urine, or the kidney secrete bile? What gland, then, will be able to perform so peculiar an office as this of adding vesicles or coverings to the central parts of the blood?

After all this long dream about the vesicles and their central parts, the best physiologists of the present day seem to deny that they exist.

But one author has finished this career of useless speculation, by maintaining that the LIFE is in the BLOOD: and thus we have seen this simple and beautiful subject of the blood tortured through all kinds of imaginations, and running its fiery ordeal, first through mathematics, then through anatomy and all its glands, then through metaphysics; till at last we are come to talk with the most perfect ease and confidence about the most monstrous of all absurdities, the life of the blood.

"For in the blood is the life thereof," might be a useful doctrine among the Jews, if it moderated their desire for blood; and if among physicians this were to be the tendency of such a doctrine, it were very cruel and unnatural to disturb it: but, in serious earnest, it introduces into modern physiology nothing but a jargon of words, and perverts every idea that the mind of man can form of parts which excite and parts which act. Whimsical theories creep faster into physic than useful facts; and the business is fairly enough begun when surgeons, dissecting aneurisms of the carotid arteries, and who should

ſhould be employed in recording how and from what cauſes they have ariſen, or how ſuch diſeaſes affect the arterial coats, chooſe rather to inform us " that this ſtate of the blood, or rather of the coagulable lymph, may ariſe from ſome connection or ſympathy it may have with the diſeaſed ſtate of the artery." " By lightning (ſays a celebrated author), death is ſo inſtantaneouſly produced in the muſcles, that they cannot be affected by the ſtimulus of death." Connections, and unknown ſympathies, and living powers in fluids, and energies, and efforts, and intentions, and " ſympathetic congelations in the blood," and " immediate ſympathetic contiguous harmonies of cut parts," and the " diffuſed principle of life," and " the ſtimulus of death ;" are words which phyſiology would gain by loſing, and are the very cant belonging to the doctrine which I propoſe to refute.

It is not merely the doctrine of a living principle exiſting in the blood that is now to be ſpoken of, but a doctrine attributing the life of the ſolids to this living principle of the blood ; ſo that it may be intitled " the new theory concerning the blood, which is itſelf alive, which gives life to all the other parts, and which in the beginning forms all the parts out of itſelf in the mother's womb ;" ſo that a fœtus is merely a ſpeck of blood, and all the parts being formed from that ſpeck of blood, the whole of phyſiology is abrogated henceforward, and totally annulled, except this theory itſelf. It is like the ſtaff of Moſes converted into a ſerpent, which ate up the ſerpents of all the magicians who had thrown down the ſtaff before him ; for if this theory were once eſtabliſhed, there would remain nothing to be done in all the animal body but what was done by the blood ; nothing to wonder at, nothing to gueſs about, nothing to ſtudy, but this vital and plaſtic power of the blood.

The author of this doctrine ſhows us two or three ſpecks in an incubated egg; he tells us that they are dots of blood ; he tells us that this blood forms the veſſels in which this blood itſelf is to move ; it forms the limbs of the chick which theſe veſſels are to ſerve ; the bones,

mufcles, bowels, glands, the whole creature is formed out of it; and when the bird is delivered from the egg, the living principle of the blood ftill continues to fupport it. The blood heals its flefh or bones when they are broken; "the blood moves in the living folids, which it both forms and fupports."

It is not eafy to fay on which of all his proofs Mr. Hunter chiefly relies for eftablifhing a doctrine fo important as this is; whether he confiders it as a perfect proof of the vitality of the blood that it coagulates, or that this coagulum has moreover the power of becoming perfectly alive, and of forming new veffels within itfelf; or that blood feems to affift the union of contiguous parts; or that by taking away its blood a creature dies; or that a limb falls into immediate gangrene when its veffels and its fupply of blood are cut off. But chiefly he feems to rely on coagulation as a proof of the vitality of the blood; for he confiders the coagulation of the chyle as a proof that it alfo is alive; and he fays, "contraction is the life of the folids; and if we can find any thing like it (by which he means coagulation), we fhall call it the living principle of the blood."

But what harmony he can find betwixt the occafional, voluntary, regulated, contractions, of the living folid, and this fudden, irretrievable, inorganic, coagulation of the blood, I cannot conceive. Does not jelly coagulate; and what is it but a part of the blood? Does not glue congeal, diffolve, and congeal again, yet what is it but an animal jelly? Does the blood itfelf ever congeal till it is out of the body, or extravafated in aneurifmal facs? When it is out of the body, it coagulates; when it coagulates, it is dead: coagulation is fo far from refembling the contractions of the living body, that it is the marked character of dead animal matter, which you melt and coagulate again and again. Shall we then define life by faying, coagulation is the mark of the vital principle? If fo, we give the mark of its death as the proof of its living power.

But in his awkward attempts to prove this point, the author has brought himfelf into great fufpicion, and of courfe

courſe into great diſhonour, by two experiments, in which he endeavours to ſhow how this vital power, like the life of a perfect creature, is affected by cold firſt. In page 79, we are informed, that a freſh egg, in conſequence of being alive, reſiſts the cold, and is frozen with great difficulty; but being once frozen and thawed again, it loſes its living principle and its power of reſiſting cold at once; it freezes now at the ſame temperature with other animal matter, ſhowing no longer any power of generating heat, or reſiſting cold.

But we are told *, that the blood having a determined period for coagulating, you may during that time freeze the blood, and it will thaw again, and yet congeal at its proper time; and he tells us, that he had very cleverly frozen blood in the very time of its flowing from the vein, then thawed the cake, and ſtill in due time it congealed. Now ſince the egg reſiſts cold by its living principle, why did it die or loſe that living principle when converted into ice? or rather, ſince the blood coagulates through its living principle, and by a living effort, how did it preſerve its living principle after being frozen? This proves ſurely, either that the blood's coagulation has no relation to any living principle, and therefore is not affected by the cold; or that the egg has a living principle of a very different kind, which is abſolutely and totally extinguiſhed by cold. I am ſure, that had Mr. Hunter ſeen theſe two experiments brought face to face in this manner, he would have put one of them at leaſt back quietly into the portfolio from which they both came. I have always obſerved, that your great tellers of experiments need to have good memories; and I am come to look on a ſuite of experiments as coolly as upon a ſet of neat plans and figures by which the author chooſes to illuſtrate his hypotheſis.

That this coagulum, being once formed, has the power of becoming more perfectly alive, and forming veſſels within itſelf, it is not eaſy to conceive. Nothing indeed is more common than clots of blood, or depoſitions of

* Page 87.

the coagulable part, becoming highly vaſcular, by veſſels ſhooting into them from ſurrounding parts; but this is of no value in Mr. Hunter's doctrine; this is not the fact which he means to ſpeak of; this is much too natural and eaſy for him: and that his meaning may neither be miſrepreſented nor miſtaken, I quote his words; "When new veſſels are formed, they are not always elongations from the original ones, but veſſels newly formed, which afterwards open a communication with the original." That a clot of mere blood ſhould have in it a living principle, and ſhould poſſeſs through that principle the power of forming within itſelf arteries and veins, a new and independent circulation; that it ſhould have the privilege of knowing when it ſhould exert itſelf thus, is really wonderful; that it ſhould have ſome kind of intelligence, or conſciouſneſs, by which it could underſtand when it were within and when without the body; and whether in certain circumſtances it were fit that ſuch veſſels ſhould be formed! That clots ſhould have been buſied forming veſſels within them for ages, and no body ever have ſeen the proceſs going on! That Mr. Hunter, who has been looking out for vaſcular clots for thirty years, never ſhould have ſeen this phænomenon is all very ſurpriſing. Mr. Hunter falls into a deeper blunder in this buſineſs than in the affair of the frozen egg; he abſolutely never ſaw a proper vaſcular clot. He informs us moſt deliberately in page 92, "that he thinks he has been able to inject what he ſuſpected to be the beginning of a vaſcular formation in a coagulum, when it could not derive any veſſels from the ſurrounding parts." From whence then did this clot derive its injection? this is a queſtion which detects at once what Mr. Hunter was doing, and puts this experiment pretty much upon a footing with the frozen egg.

To ſay "that the blood, in ſome circumſtances, unites living parts by a ſort of contiguous ſympathy as certainly as the yet recent branches of one tree unite it with another," is to put forth a ſyllogiſm, in which both major and minor propoſitions are untrue. Firſt, it is not true, that it is the juices of the tree which unite the graff

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to the ſtock; it is the living fibres, and the living veſſels of both; and unleſs both be alive, the proceſs muſt fail, living juices would do no good. Secondly, though the juices did ſo unite or glue together the branches of a tree, that were no proof of the juices being alive; but only that good juices, whether alive or not alive, were neceſſary to the proceſs.

Any man who affirms that in ſurgical operations it is the blood, "that by a contiguous ſympathy unites the parts," ſhould have ſupported his aſſertion by this further argument, that without blood they will not unite. Prove to me only that freſh cut parts are not alive, and cannot naturally unite without the aſſiſtance of ſome foreign power, and then I will acknowledge willingly that they are altogether beholden to the intermediation of the blood, with its living principle, and ſympathy of contiguity.

But it is very ſingular, that any perſon, even the leaſt inſtructed in forms of reaſoning, ſhould have advanced this as any proof of living principle in the blood, "that mortification immediately follows where the circulation is cut off;" for this proves merely, that the blood is one of many ſtimuli, by which the ſyſtem is ſupported, in ſo much, that each limb is affected juſt as the whole body would be; and whether you ſtop the blood, which is one ſtimulus, or take away its heat, which is the ſtimulus next in power to the blood, the limb will equally die.

To ſay that the life is in the blood, becauſe the blood being taken away the limb dies, or becauſe an animal may be bled till it dies; what is this but to jumble all diſtinction of cauſe and effect? The water, no doubt, is the life of the mill, and the plough-horſe is the very life of the plough; for the mill and the plough are dead the moment that the horſe is gone or the water fails.

Laſtly, we are told "that it is by the contiguous ſympathy of the blood and body both being alive," that they both work upon each other mutually: but is it not very ſtrange for any phyſiologiſt to forget, that the blood is at leaſt in part a foreign body, that it muſt be continually impregnated with air, that it is neither its original

constitution, nor these presumed sympathies that make it vital blood, that it becomes vital blood only by exposure to air, and that if this foreign principle be not continually added, the solids are not wrought upon by the blood?

The natural difficulties of this doctrine are very great; for it seems to be against all the laws of nature that any fluid should be endowed with life. A fluid is a body whose particles often are not homogeneous, have no stable connection with each other, change their place by motion, change their nature by chemical attractions and new arrangements; a body which can have no perfect character, no permanent nature, no living powers connected with it. But the definition of a solid is the reverse of this: a solid among every kind of metals, earths, or fossils, is recognized by its peculiar form and arrangement of parts: and in the animal body, the arrangement of particles gives the permanent unchanging character of each part; and in the muscles, for example, or in the nerves, where feeling and irritability chiefly reside, the form and mechanism of the solid is in each most peculiar, and is always the same.

What is this blood that it should begin life and support it, and distribute it through all the system? Is it not a fluid which varies every hour, now richer, now poorer, now loaded with salts, now drowned in serum, now much, now sparingly supplied with air, now darker coloured, now red, now fully supplied with chyle, and now starved of its usual supply? Is it not lost in astonishing quantities in hæmorrhages, and drawn very freely from our veins upon the slightest disease? That such qualities are consistent with life in the blood, is what I cannot believe. But I can most easily imagine how the system, having by successive operations converted the food into chyle, the chyle into blood, and fashioned the nutritious part of the blood into various solids; these new solids may partake of the vitality of all the parts to which they are applied, and to which they have been assimilated by so peculiar and so slow a process.

The question is plainly this: Shall we follow the ge-

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neral laws of the ſyſtem, ſuch as phyſiology acknowledges? or ſhall we admit an abſurd novelty without proof? Shall we allow of the ſimple accident of coagulation (an accident common to dead fluids) as a proof of life? or ſhall we forget thoſe ſtupendous proofs of the irritability reſiding in the heart, muſcles, and other forms of our living ſolids, and which is the ſource of all the various actions of the body? Shall we forget that polypi, worms, inſects, the bloodleſs parts of fiſhes, the uncoloured parts of the human body, even plants almoſt inanimate, all partake of life, without having red blood in their ſyſtem, or having it reſtricted to the central parts? All theſe have life and vitality, but where is their blood? In ſhort the queſtion plainly reſolves itſelf into this, Shall we have two living parts, fluid and ſolid; two agents acting on each other? or ſhall we follow the common law of the œconomy, call the one an exciting power, while the other receives that excitement, being alive only that it may feel and act according to the degree in which it is moved? Shall we have the blood communicating life to all the body? or the body only alive, and the blood, like various other excitements, acting upon it with thoſe powers which it is continually acquiring, without acquiring along with them any ſhare of life?

But Mr. Hunter, ill contented with his doctrine himſelf, he even who began with giving to the blood a vital principle, and calling it the former of new parts, and the ſubſtance whence the living ſolid derives its life, hatches a new doctrine out of the confuſion of the firſt; takes from the blood all thoſe high privileges in the ſyſtem which he had ſo freely beſtowed upon it, and gives them in full perpetuity to a new principle, a principium vitæ diffuſæ, which he announces thus:

"I would conſider that ſomething ſimilar to the ſubſtance of the brain is diffuſed through the body, and even contained in the blood; and between this (viz. the matter diffuſed in the blood) and the brain the communication is kept up by nerves." This matter he does not like to define, but he muſt name it; and

having

having obſerved, as others have done, that a mouthful of nonſenſe ſounds infinitely better in Latin than in our mother tongue, he calls it the "Materia vitæ diffuſa."—Concerning this diffuſed principle of life, he tells us, that every part of an animal has its due proportion; it unites all the body into one; "it is as it were diffuſed through the whole ſolids and fluids, making a neceſſary conſtituent part of them, and forming with them a perfect whole."—The terms in which this doctrine is propoſed are hardly more intelligible than thoſe in which he argues about the life of the blood; the matter itſelf reſembling the ſubſtance of the brain, is ſuppoſed! the manner of its union with the blood is ſuppoſed! its connection at once with the fluids, and with the living ſolids, is ſuppoſed! the ſort, of a manner, in which this matter harmonizes the whole, is ſuppoſed! and now the coagulation, and life of the blood, is no longer an effort of the life of the blood, but of the materia vitæ diffuſa; and the blood does not form the ſolids, the blood no longer communicates life to the ſolids, but the blood and the ſolids are both at once animated by this DIFFUSED PRINCIPLE OF LIFE.

No one need triumph over a doctrine which thus falls by its own weight; but this muſt not be forgotten, that the doctrine of the life of the blood leads to a mean contracted narrow view, not merely of this but of higher ſubjects.

Plants have active and irritable fibres; by the moſt curious actions they drink in water; water alone they can convert, by the moſt ſimple mechaniſm, into moſt delicate perfumes, into delicious fruits, or into terrible poiſons. "There ſtands," ſays Blumenbach, "a hyacinth before me; generations of theſe flowers, of which this is the laſt, have grown there ſucceſſively, touching the ſurface merely of a little water;" but ſhall Mr. Hunter perſuade me that this water is alive? "vel hyacinthi me monent *."

I think I may ſafely conclude, that theſe theoriſts have

* Page 27.

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done the fcience no good; themfelves no honour; and us no kind of benefit, unlefs it be an advantage to know that by none of thefe ways can we arrive at a knowledge of the blood.

QUALITIES OF THE BLOOD.

Blood is a fluid of a rich and beautiful colour; it is vermilion-coloured in the arteries, ftrong purple in the veins, and black, or almoft fo, at the right fide of the heart; it feels thick and unctuous betwixt the fingers, is of a flightly faline-tafte, is various in various parts of the body, in the heart or at the centre of the circulation different from what it is in the glands, excretories, and all the extremities of the body; different in the liver, among the inteftines, in the cheeks, and lips, in the refervoir or finufes of the head and womb. In various individuals, but much more in different animals, it varies with their functions and manner of life; it is more or lefs perfect in animals, in birds, in fifhes, in infects; it is thick or thin; has grofs particles or fmall; is red or pale; hot or cold; according to the creature's life: and from this laft variety, viz. of the manner of life, comes our divifion of animals into thofe of hot and cold blood.

It is by the moft fimple and natural methods that we examine the blood; fince almoft fpontaneoufly it refolves itfelf into the CRASSAMENTUM, the SERUM, and the RED GLOBULES, fufpended in the craffamentum, and forming a part of it. In a cup of blood, the craffamentum, or clot, the hepar fanguineum, as it was called long ago, floats in the ferum; the red globules are engaged in this clot, and give it colour; the ferum may be poured off, the coagulum may be wafhed till it is freed of the red parts of the blood; and then the red particles are found in the water with which the coagulum was wafhed, and the coagulum remains upon the ftrainer, little reduced in fize, pure and white, the fibrine or gluten. Or we may feparate this part by a method which Ruyfch firft taught us; we may, while the

 blood

blood is congealing, ſtir it with a bunch of rods, when the pure and colourleſs fibrine gathers upon the rods, and the ſerum, with the red particles ſuſpended in it, remains behind.

OF THE RED GLOBULES.

The red globules, as we have obſerved, are not univerſal; yet in all creatures, even in colourleſs inſects, there ſeem to be formal particles in the blood; in white inſects, they are white, in green inſects, they are green, in moſt inſects they are tranſparent.

The red globules of the human blood are eaſily ſeen; they are beſt examined with a ſimple lens, the globules being diluted in ſerum, and laid upon an inclined plane, not in water, which diſſolves them quickly, but in ſerum, which has the property of preſerving their globular form.—The ſize of the particles of the blood varies in various creatures; in the fœtus, they are bigger than in a grown animal; and although Leeuwenhoek thought it eſſential to his doctrine, to ſay, that they were alike in all creatures, we know beyond a doubt that there are in reſpect to the ſize of the animals the ſtrangeſt reverſes. The Skate has red globules much larger, and the ox has globules much ſmaller, than thoſe of a man. Fiſh have large globules, Serpents ſmaller ones, and Man ſmaller ſtill. In Man the diameter of each globule is much leſs than the three thouſandth part of an inch.

There is in the effect of lenſes, or in the nature of theſe globules, ſome ſtrange refraction, by which there ſeems a darkneſs in the centre of each globule, and thence a deception which has been univerſal; ſo that no ſingle deſcription has tallied with that which went before. Leeuwenhoek believed, that he ſaw them conſiſting each of ſix well compacted ſmaller globules: Hewſon believed that they were bladders, which had within them ſome central body, looſe and moveable; that often the central part might be ſeen rolling in its bag; and that ſometimes the bladder was ſhrunk and ſhrivelled around the central body, and could, by putting

ting a drop of water upon it, be plumped up again. The Abbé Torre examined them with ſimple lenſes too; but they magnified ſo highly, that from this cauſe all his noiſy miſtake has ariſen; for he uſed not ground lenſes, but ſmall ſphericles of glaſs formed by dropping melted glaſs into water; they magnified ſo much, that to him the central ſpot appeared much darker; he ſaid that theſe were not globules, but rings. He ſent his ſphericles of glaſs and his obſervations from Italy, his own country, to our Royal Society; and for a long while, though nobody could ſee them, ſtill the public were annoyed by Abbé Torre's rings. Falconer, with all the zeal of a friend, publiſhed Hewſon's diſcoveries after he was dead; lamenting, as we all muſt do, the loſs of a promiſing young man. Falconer thought he ſaw theſe globules, not as ſpheres, but as flattened ſpheres; he thought he ſaw them often as they rolled down the inclined plane upon which he placed them, turning their edges, their ſides, their faces, towards the eye; he even compared their flatneſs with that of a coin. Many authors have conjectured that theſe globules are compreſſed when they come into narrow paſſages, and expand again when they get into wider arteries. This Reichell ſays he has ſeen, and Blumenbach believes; but Blumenbach, leſs eaſy of belief with regard to all theſe ſtrange forms aſcribed to the particles of the blood, pronounces his diſſent in plain terms. "They appear," ſays he, "to my eye no other than ſimple globules apparently of mucus: that lenticular or oval form which authors ſpeak of, I have not ſeen."

The following are their chief properties with regard to the reſt of the blood. When blood ſtands, they fall to the bottom, becauſe they are heavier than the other parts of the blood; and although the fibrine or gluten entangles them while it is forming, ſtill it is to be noticed that the cake is always redder at the bottom; and when by weakneſs or diſeaſe this coagulation is very ſlow, ſome globules eſcape the graſp of the coagulum, and the ſerum is tinged with red, and the cake, though coloured at the bottom, is white at the top,

or

or has the buffy coat. Their form they preferve only while in the blood, and feem to be fupported more by the qualities of the ferum than by their own properties; for if mixed with water, they mix eafily, and totally diffolve; the water is red, but the globules are gone; when we mean to preferve their forms for experiment, we muft keep them in ferum, or muft make an artificial ferum by impregnating water with falts. Their quantity, in regard to the whole mafs, varies fo, that the appearance of the blood is a real index of health or difeafe: in difeafe and weaknefs, the blood is poor and colourlefs; in health and ftrength, it is rich and florid; by labour, red particles may be accumulated in a wonderful degree; in hard working men they abound; they may be accumulated by exercife into particular parts, as in the wings of Moorfowl or Pigeons, and in the legs of common Hens. In fhort, the red globules are numerous in health; in large and ftrong creatures; and in the centre of the fyftem, where they often circulate, when (as in fifhes) all the flefh is colourlefs; in fuch a fyftem, particular glands only, or vifcera, as the liver, ftomach, or fpleen, are coloured with blood, and but a fmall proportion circulates in the great veffels round the heart.

The rednefs of thefe particles is a peculiarity for which we know no meaning nor caufe. The greateft phyfiologifts have afcribed it to the iron of the blood; but when we reflect how many various colours iron gives in its various ftates; when we reflect, that the unknown caufe which gives colour to the iron may give colour to the blood; when we reflect, that of this crocus of iron we can hardly procure one poor grain from four hundred grains of thefe red particles of the blood;—we cannot but be confcious that this peculiarity is not yet explained.

COAGULABLE

COAGULABLE LYMPH.

The coagulable part, the cake which is left when we wash away the red globules, that which has been called the gluten, and now by chemists the fibrin, is by far the most important part of the blood, the most universally diffused in the animal system, the most necessary for the supply and growth of parts. It forms all the solids, and in its properties resembles them most curiously; for this cake, when washed, is white, insipid, extremely tenacious, and very fibrous; can be drawn out greatly; and it is the coagulation of this part that makes the long fibrous strings which we find in the tub when bleeding a patient in the foot in very hot water. Being slightly dried, it shrinks into a substance like parchment; being hardened by heat, it becomes like a piece of horn or bone: when burnt, it shrinks and crackles, with a very fetid smell, like the burning of feathers, wool, flesh, or any other animal substance; by which we know it to be the part of the blood which is the most perfectly animalized, and the most ready to be assimilated with the living solids. When distilled, it gives ammoniacal salt and alkaline water, and a very thick heavy fetid oil, and much mephitis, which are the marks of the most perfect animal nature; and after burning it, the residuum is a phosphate of lime, or, in other words, the earth of bones.

Its peculiar properties, as it appears in the blood, are few; its relation to the body is very surprising.

What passes within the animal body, or how this gluten is directly applied, we never can know; but we see how the greater part of the body is composed of gluten, and no analysis of any single part has ever disappointed us. A muscle being squeezed, and thoroughly cleansed of blood, washed in spirits of wine, and again cleaned, is seen plainly to be but a peculiar form of coagulable lymph. A bone being infused in any mineral acid, or in vinegar, its earthy parts are dissolved even to its centre; it becomes soft and flexible, still retains the form

form of a bone; but what remains confifts principally of coagulable lymph. And though Fourcroy is certainly right in faying that coagulable lymph is that part upon which nature fixes irritability, or the contractile power, he fhould have added, " but this gluten is moreover in the animal body the bafis of every part which poffeffes life;" it conftitutes, in truth, no lefs than nine-tenths of the folids of the whole body. The membranes, ligaments, tendons, periofteums, and all the white parts of the animal body, confift chiefly of this. It is this fibrous part, then, which is fecreted by the veffels for repairing all the waftes and all the accidents of the body; when a mufcle is wafted by violent action, or by fevers, or by long confinement is abforbed, gluten is fecreted to fill it up; when a bone is broken, much of this jelly is depofited in a bed for veffels to ftretch into, and a new bone is quickly formed; when foft parts are cut, gluten is poured out betwixt them; when vifcera are inflamed, pure gluten, white, and membranaceous-like, is poured out betwixt them; when the uterus is to be prepared for receiving the impregnated ovum, gluten is poured out into the womb; and in all thefe cafes it is the foundation of a union with the furrounding parts. In fhort, this gluten forms, nourifhes, fupports, reftores the parts of the animal body; but far from confidering it either fimply, or along with red globules, as containing the principle of life, I find it as perfect in dead vegetables as in living animals; and view it only as that particular form of matter which nature has wifely appointed for our chief nourifhment and fupport.

THE SERUM.

The ferum is the thinneft and moft fluid of the parts of the blood, into which it fpontaneoufly feparates. And it contains thofe fubftances which one is almoft tempted to call extraneous: this muft be kept in view when its properties are to be told, for though it fo exactly refembles the white of an egg, that fome have in comparing the two, written whole pamphlets on the fubject,

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and named it the Albuminous Fluid, although it coagulates like gluten, although it putrefies like flesh, although it gives out, upon distillation, ammonia and a black and fetid oil; yet it is most natural that, along with these it should contain also some foreign bodies, as a saccharine or extractive matter, belonging to vegetables, and some proportion of the oxalic, malic, or other vegetable acids.

Serum is a fluid like whey, of a yellowish, or rather greenish colour, of an unctuous or slippery feeling among the fingers; it is slightly saline, and contains soda, sulphur, and phosphate of iron. It contains soda completely formed, by which it turns vegetable reds to green; it coagulates with a heat much lower than that which makes it boil; being dropped into hot water it coagulates as it falls; by 150 degrees of heat it coagulates into an albumen like the white of an egg.

But by this influence of heat the whole does not coagulate, but only the albumen, a substance like the white of an egg; what remains fluid is the serosity. On cooling, the serosity coagulates like size or jelly. This coagulation arises from the gelatin dissolved in the water; and this gelatin may be precipitated by various re-agents, but especially by tanin, and by alkohol. After the separation of the gelatin, there remains only the salts in watery solution; these are muriate of soda, phosphate of soda, and phosphate of lime.

This analysis of the blood contains the analysis of almost all the humours or secretions of the body. Observe how nearly the urine resembles the serum; indeed the urine, like the serum, preserves the peculiar form of the red globules, and sweat is but a serum loaded with salts; observe how little saliva differs from the serum; observe how perfectly the serum resembles milk, since mixing serum with water produces a milky fluid, that is, a fluid which gathers cream on the top, and coagulates with acids and heat. The water of dropsies is purely serum; the mucus of hollow passages is little else than inspissated serum; the bile itself is said to be imitated by keeping putrid blood. In short it is obvious that on the coagulable lymph depend all the internal secretions, *i. e.*

for supplying the waste of the system, for enabling it to grow, for repairing bruised or cut flesh, or broken bones; that on the serum which dilutes the blood, and contains all such foreign bodies as might be injurious to the system, all the excretions, as urine, sweat, saliva, tears, &c. &c. depend *.

I have said, "that the blood is a fluid of a rich and beautiful colour; vermilion-coloured in the arteries, strong purple in the veins, and black, or almost so, at the right side of the heart." When we open the thorax of a living Dog, the lungs collapse, the heart soon ceases to play, the Dog languishes, expires, is revived again when we blow up its lungs:—then begins again the motion of the heart, the black blood of the right auricle is driven into the lungs; the blood goes round to the left side of the heart of a florid red; and this purple blood of the veins, the vermilion blood of the arteries, the change happening so plainly from access of air, is a phenomenon of the most interesting nature, and binds us to look into the doctrines of chemistry for the solution of a phenomenon to which there is in all the animal economy nothing equal.

It is the study of air and aërial fluids that has brought to light all the beautiful discoveries of which modern chemistry can boast. The simplicity of the facts in chemistry, the correctness of the reasoning, the grandeur which now the whole science assumes, is very pleasing; and makes us not without hope, that by this science, all others, and ours in an especial manner, may be improved; for the action of vessels will do much in form-

* When the blood and solids of animal bodies come to be resolved into their ultimate parts, we find a variety of combinations which belongs to another science, and which in this place it were tedious to explain. But still there is one great distinction betwixt animal and vegetable matter, which should not be left unnoticed. Animal matters always, when dissolved by nature, fall into a putrid state, and give only volatile alkali. Vegetables, when they dissolve, fall into fermentation, and produce acids or wine; not that alkalis are necessarily contained in their formal state in the animal body, but that the animal body contains much mephitis or basis of nitrous air, which, combining with the inflammable air afforded by decomposed water or by their oils, forms the volatile alkali.

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ing and changing our fluids: all the reſt is chemiſtry alone.

The older chemiſts were coarſe in their methods, bold in their conjectures, in theory eaſily ſatisfied with any thing which others would receive. They condeſcended to repeat inceſſantly the ſame unvarying proceſs over each article of the materia medica; and among hundreds of medicinal plants which they had thus analyſed, they could find no variety of principles, nor any other variety of parts and names than thoſe of phlegm, and oil, and alkali, and acid, and ſulphur, and coal. By this they diſburthened their conſciences of all they knew, pleaſed their ſcholars, and ſet the phyſicians to work, forming magnificent theories of ſalts, ſulphurs, and oils; for ſuch has ever been the connection of chemiſtry with phyſiology, that, good or bad, they have ſtill gone hand in hand.

The older chemiſts thought that they had arrived at the pure elements, while they were working groſsly among the groſſer parts of bodies. They could know nothing of the aërial forms of bodies, for they allowed theſe parts to eſcape. When their ſubjects, by extreme force of heat, roſe upwards in the form of air, no further inveſtigation was attempted; it was ſuppoſed that the ſubject of their operation was conſumed, annihilated, waſted into air, and quite gone. When they thus ſtopped at airs, they ſtopped where only their analyſis became intereſting or ſimple; ſtopping where they ſtopped, among their oils and ſulphurs, they made their ſcience a mere rhapſody of words. Philoſophy they conſidered ſo little, as not to know that the lighteſt air is really a heavy body, and that with weight and ſubſtance other properties muſt be preſumed.

Modern chemiſtry begins by aſſuring us, that theſe airs are often the denſeſt bodies in the rareſt forms; that airs are as material, as manifeſt to the ſenſes, as fairly ſubject to our operations, as the denſe bodies from which they are produced: That it is heat alone (a ſubſtance which irreſiſtibly forces its way into all bodies) that converts any ſubſtance into the aërial form:

form: That ſome bodies require for their fluidity merely the heat of the atmoſphere, and ſo cannot appear on this planet in any ſolid form: That others require ſome new principle to be added, in order to give them the gaſeous or aërial form: That others require very intenſe heat to force them into this ſtate; but that all aërial fluids ariſe, or muſt be preſumed to ariſe, from ſome ſolid body or baſis, which ſolid baſis is dilated by heat into an air. The ſolid baſis of ſome airs can be made apparent, as of fixed air, which proceeds from charcoal; others, as pure air, or azotic air (the great conſtituents of our atmoſphere), cannot be produced to view in any ſolid form. But thoſe airs which cannot be exhibited in any ſolid form, can yet be ſo combined with other bodies as to increaſe their weight, and give them qualities of a very peculiar nature; and theſe airs can be alternately combined with a body and abſtracted again, adding or abſtracting from its weight and chemical properties, not only in a perceptible, but in a wonderful degree; ſo that theſe abſtractions and combinations conſtitute ſome of the moſt general and important facts. When the old chemiſts, then, neglected to examine theſe airs, they refrained from examining the laſt elements of bodies at the very moment in which they came within their power.

That theſe muſt be the moſt material and important facts in all the ſcience, it is eaſy to explain; for chemiſtry, ever ſince it has been a ſcience, has reſted upon one ſingle point. There are certain great operations in chemiſtry which we perceive to have the ſtricteſt analogy with each other, or rather to be the ſame; the operations are, the combuſtion of inflammable bodies, the reſpiration of animals, the calcination of metals; and whatever theory explains one explains the whole. The older chemiſts obſerved, that when they burnt an inflammable body, the ſurrounding air was contaminated, the ſubſtance itſelf was annihilated, nothing remained of its former exiſtence but the foul air; and they ſuppoſed that this inflammable body conſiſted of a pure inflammable principle, which was the ſubſtance which ſpoiled

the air, lessening its bulk, and making it unfit for supporting any longer either combustion or animal life. When an animal breathed in confined air, they found the phenomenon still the same; the animal contaminated the air, and expired itself; left the air unfit for burning or breathing, loaded, as they supposed, with the inflammable principle. When they calcined a metal (which is done merely by heating the metal and exposing it to air), they found, as in these other operations, the air contaminated, the metal losing its metallic lustre, ductility, and all the marks of a metal,—acquiring (in certain examples) new qualities, like those of some mineral acid, and becoming of course a most caustic drug; but above all, they uniformly observed the metal to increase in weight.

To account for all these discordant changes was the most difficult part of all: it was indeed easy to say, that combustion was the giving out of an inflammable principle to the air; and to say concerning respiration, that it was the business of the air to take away continually the superabundant phlogiston of the blood; but how a metal should pass from a mild to a most acrimonious and caustic state; and above all, how by the loss of its inflammable principle it should not lose in weight, but increase in weight! This was the Gordian knot which they had to untie, and which they cut lustily, betaking themselves, in defiance of all philosophy, to the absurd project of a principle of absolute lightness. They all agreed to call the phlogistic principle, a principle of absolute levity; and thus their doctrine stood for many years, viz. that when phlogiston, or inflammable principle, was added to the calx of any metal, as to red lead, by roasting it with any inflammable body—the metallic lustre, tenacity, ductility, were restored, and the metal became lighter withal, because it now had within it the principle of levity. But that when by heat and air it was calcined, this principle was driven out, and then the metallic lustre, tenacity, ductility, &c. were lost by the absence of the inflammable principle upon which they all depended; but the weight of it was increased, for the principle of levity was gone.

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This is the brief abſtract of the theory to which the very beſt chemiſts have addicted themſelves down to the preſent times.

But the chief perfection of modern chemiſtry is, that its apparatus is ſo perfect, that it can employ exactly a certain quantity of air in calcining a metal; it can collect that air again to the twentieth part of a grain; it can prove whether the metal has really been giving out any inflammable principle to the air, or whether it has received matter from the air, and how much expreſsly it has gained or loſt. Modern chemiſtry proves to us, that it is not the loſs of any principle that endows a metal, for example, with negative powers: but the direct acquiſition of a new principle, which endows it with poſitive powers. Thus if you take a quantity of mercury, and expoſe it ſlowly, that is, for a long time to heat and air, the following changes take place; it gradually loſes its metallic luſtre, the upper part of it aſſumes firſt a yellow and then a red colour, ſmall red particles are ſeen floating on the ſurface of the mercury; and theſe are the mercurius precipitatus per ſe, a moſt acrid calx of mercury. If, firſt, you eſtimate how much air has been expended during the proceſs, you find that the weight of the mercury is increaſed in exact proportion; if you put that calx into a gun-barrel, put the gun-barrel into the fire, and by mere force of heat drive out this air, you find the quantity of air exactly equivalent to the quantity expended in the proceſs; you find the metal grow lighter, and recover its metallic qualities and luſtre in proportion as the air is expelled. In ſhort, we find the metal heavier when combined with air, lighter when the air is driven out; we find it having the qualities of a metal when uncombined with air, when combined with air having the qualities of a calx: then plainly this cauſtic form of the metal is not a negative quality, it is a poſitive one, proceeding from the infuſion of this new principle from the air.

By ſuch proofs as theſe chemiſtry has explained, in a moſt philoſophical way, how all theſe phlogiſtic proceſſes, as they were called, depend, not on the abſtraction of

 phlogiſton,

phlogiston, but on the addition of a new principle: That they all arise from one positive power, that the same principle gives life to fuel, heavinefs (and other effects of calcination) to metals, acidity to acids, and rednefs to the blood. These are all performed by one power; they are all effentially one procefs; they are all effected by the communication of one fole principle, viz. the bafis of pure air.

Upon our atmofphere and its furprifing harmony with all parts of nature; with animal and vegetable life; with water, metals, acids, and all the folid bodies into which it enters—much more depends than it is eafy to conceive. Could we have fuppofed that it was the caufe, not merely of life in all living creatures, but almoft the caufe of all the properties that refide in the moft folid forms? Could we have fuppofed that the air rendered heavy bodies heavier, changed metals into the moft cauftic fubftances, converted many bodies into acids, changed inflammable air into the pure element of water, which at leaft we have hitherto conceived to be pure? Yet if there be one word of truth in chemiftry, all this is true.

The atmofphere contains various gafes or airs; but one only, viz. vital air or oxygen gas, is ufeful to refpiration, combuftion, and animal life; that purer air muft, like every other, arife from fome folid bafis: That bafis cannot be fhown in any fubftantial form, but it can be combined with many various bodies, fo as to give them an increafed weight and new qualities; and thence we prefume to fay, whenever we fee a body, by fuch a procefs, acquiring fuch qualities, that it acquires them by abforbing the bafis of pure air; for pure air is nothing but this prefumed bafis dilated into the form of air by heat; and when it combines with any body, it gives out its heat; fo that in all thefe proceffes heat is produced. And although inflammable bodies, metals, acids, and animal blood, feem very diftinct from each other; although combuftion, breathing, calcination, and the forming of acids, are proceffes feemingly very unlike; yet they are all in their effential points the fame, viz. a change of qualities

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and a production of heat in consequence of the absorption of pure air.

First, when an inflammable body is BURNT or consumed by fire, the basis of pure air is combining with the combustible body; the air is entering into a new combination, and therefore must give out its heat; it combines rapidly, gives out its heat rapidly, is wasted; the inflammable body burns and seems to be consumed; but if we catch that air which escapes from the inflammable body, we find it to be equal exactly to the whole weight of the air and of the burning body that have been consumed; and this air consists of two parts, viz. of the substance which was burnt, and of the basis of pure air. Thus, for example, when we burn charcoal or carbon, the whole substance of it, weight for weight, is converted into an air, which is called fixed or carbonic acid gas; the same which is discharged from stoves, the same also which is found in pits, the same which oozes through the ground in the Grotto del Cane, the same which floats upon the surface of fermenting vats, and which is so much heavier than common air that it can be taken out from a vat in basons, and poured from dish to dish. Combustion, then, is a process which consists in the rapid assumption of the basis of pure air, and a consequent conversion of the burning body into an air or gas endowed with peculiar qualities and powers.

If, then, the oxygenation of the blood be a process like this, it must differ chiefly in degree; it might in certain circumstances become too rapid, and resemble an actual combustion; and so in certain circumstances it does, for our atmosphere is so tempered that no more than 27 parts out of 100 consists of pure air; the rest is food for vegetables, but not fit to maintain flame or animal life. This is the reason that even burning as well as breathing are slow processes, and that an animal, if made to breathe pure air, or vital air as it is called, gets oxygen too rapidly supplied, is consumed and inflamed quickly, and dies.

Secondly, the process of CALCINATION is the same in all

all metals; it alſo is an aſſumption of the pure air, or rather of its baſis, with a change of qualities and increaſe of weight: if you calcine lead ſlowly, it becomes firſt yellow, then orange, then red; it becomes heavier, ſo that from 100 pounds of lead you have 110 pounds of lytharge, or calx of lead: if you calcine mercury, it alſo becomes firſt yellow, then red, and much heavier than at firſt: if you diſtil any of theſe metals, you can by heat merely drive out the pureſt air from them; they recover their brilliancy, and grow lighter, becauſe the baſis of air is expelled. The baſis of pure air is expelled, not in that ſolid form in which it was embodied by the calx, but being now combined with heat, it appears in the form of vital air; the air is much purer than that of the atmoſphere which was uſed in the proceſs, becauſe the metal abſorbs or appropriates to itſelf nothing but the pureſt air, leaving the azotic or foul air behind; and finally, if you wiſh to ſee the harmony betwixt combuſtion and calcination, or to be aſſured that calcination is truly the burning of a metal, take ſome of this pure air, which is three times purer than the atmoſphere, and raiſes an intenſer flame; plunge into it a piece of iron wire, which is made red-hot; and this wire (which would only have waſted or ruſted into a calx in the common atmoſphere) will in the pure air burſt out into a brilliant white flame, and burn entirely while it has ſuch air; nay, ſome metals, as zinc, burn even in our common atmoſphere with a moſt brilliant flame.

From this ſecond proceſs, muſt it not be preſumed that the principle which gives an increaſe of weight and ſuch ſingular properties to various metals, muſt have very intereſting effects upon the blood?

Thirdly, it is from this principle alſo that all acids are formed; and as oxyd is the Greek name for acid, the great Lavoiſier has thought fit to give a name to the baſis of air, or that principle which is obvious only when operating in ſuch proceſſes as theſe. He adds to the Greek name for acid that verb which implies the generation of any ſubſtance; he calls it thus oxygene, or the

the principle which generates acids. It were eafy to fhow how truly this great point is fupported by all the particular operations in chemiftry; it fhall be fufficient to obferve a few. When we burn fulphur in open air, it feems to be confumed; but when we burn it in clofe veffels, ftill giving a free accefs to air, we find it converted into an acid the moft ponderous of all, weighing greatly more than the fulphur from which it was procured. The operation is done in clofe veffels: nothing can pafs but what is known, and nothing is more certain than that the whole of this wonderful and rapid change is the mere effect of the fulphur, which is an acidifiable bafe, affuming the acidifying principle by which alone it can become an acid. Phofphorus being burnt in a clofe glafs upon the point of a wire, the vital part of the atmofphere is confumed, the azotic air (which the ancients miftook for their phlogifton) remains, the whole phofphorus is changed into phofphoric acid, and the whole acid, when weighed, exprefsly equals the phofphorus which was burnt, and the air which was confumed along with it. Nay, arfenic, which is a metal, being calcined, is converted into a perfect acid. Thus we fee, firft, that calcination is a mere combuftion, fince it can be made fo rapid as to be attended with heat and flame; next we fee that acidification is, like calcination, attended with heat and flame, and an acquifition of weight and of properties like thofe of calces. We fee fome metals converted into proper acids; acids and metals mixing in qualities with each other, acids and metals are both acidifiable bafes, both are capable of receiving new and fimilar properties, by affuming into their compofition the bafis of pure air; and in one fingle procefs the whole fet of phenomena are exemplified, for in burning arfenic we have combuftion, calcination and generation of acid, all in one procefs, the product being named indifferently oxyd of arfenic, or white calx of arfenic *.

But

* It is neceffary to add nitre to make it burn. The refult is not directly an acid, but a neutral falt formed of the arfenical acid joined to the alkali of nitre; without the help of nitrous acid it is only an oxyd

But if most acidifiable bases be thus forced by combination to forsake their solid and assume their aërial form, others more singular still are recalled from their aërial form, and condensed into the fluid form of a strong acid. Thus azotic or nitrogene air, which forms the great bulk of our atmosphere, is converted by oxygenous or pure air into an acid form *; it becomes nitrous acid, nitric acid, nitrous air, strong or weak according to the various degrees of oxygenation communicated to it; and thus nitrous air, by its appetite for oxygene, and by its change of colour and its condensation, whenever it takes oxygene from the air, makes an eudiometer or measure for the purity of the air; and, according to the purity of the atmosphere, more turbidness and more redness is produced in the nitrous air, and a greater loss of bulk, which may be marked on a scale.

The oxydation of the blood makes a fact no less important in physiology than those are in chemistry; for as there are various marks of the influence of oxygene on the blood itself, there are terrible proofs of its importance in the system, and how miserable the person is who has imperfect organs, or an ill oxygenated blood.

Nature, disregarding all occasional supplies, as by the absorption of the skin, the assimilation of aliments, &c. has appointed one great organ for the oxygenation of the blood, viz. the lungs. In opening the breast of a living creature we best see the connection of respiration with the great system; but it is out of the body that we can best understand its particular effects upon the BLOOD.

The most obvious effect of air is its heightening the colour of the blood. If we expose blood to fixed

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oxyd or imperfect acid; and it is necessary to use the hyper-oxygenated muriatic acid for communicating to it a sufficiency of oxygene to constitute it a perfect acid.

* *N. B.* It is necessary to inclose them in one vessel, and to pass the electric spark through them that they may unite.

air,

air, or azotic air, it continues dark; theſe fluids communicate nothing, they have no effect on the colour of the blood: when we expoſe blood to atmoſpheric air, it aſſumes a florid colour; for in the atmoſphere there is a large proportion of oxygene gas: if laſtly, we expoſe it to oxygene gas, the pureſt of all air, it grows extremely florid; and whenever it changes its colour, it is by abſorbing oxygene, for it reduces in the ſame proportion the quantity of air; what it abſorbs is the oxygene or pure air, what it leaves is mephitis, unfit for combuſtion or animal life.

Blood when expoſed to the air becomes red chiefly on the ſurface, it remains black beneath, but by turning up the clot to the air all the ſurfaces become red. If air be blown into a tied vein, the blood which was black in the vein becomes florid; and when the air is preſſed out again, it becomes black. If the air-pump be exhauſted over a diſh of blood, the blood becomes dark in the vacuum; and it becomes florid when the air is allowed to ruſh in again. If you expoſe blood in a moiſt bladder, the blood is oxygenated through the walls of the bladder*; which brings this experiment as cloſe as may be to the phenomenon of blood oxygenated through the walls of the lungs. Though ſerum or milk be interpoſed, or urine, ſtill the blood is oygenated, becauſe theſe are perfect animal fluids; but it is not oxygenated, if oil, mucilage, or mere water, be interpoſed.

When we open a Frog, or Newt*, or other amphibious creature, we ſee a long and ſlender artery, accompanied by a ſlender vein, running from top to bottom along the whole ſurface of their lungs; and while their heart continues to beat, we ſee this pulmonic artery black, the vein red, the lungs themſelves moſt delicate and pellucid, like the ſwimming bladder of a fiſh: Even in the extremities of the human ſyſtem the blood of a vein is dark, of an artery red; ſo that ſurgeons diſtinguiſh venous and arterial hæmorrhagies in this way.

* See Chap. III.

From

From theſe facts we may underſtand why the blood of the womb, of ſinuſes, of varices, and of all ſtagnant veins, is ſo offenſive and black; and why that blood is ſo very pure and florid which is coughed up from the lungs. Is not the face livid in apoplexies or ſtrangulations, in hanging or drowning, in fits of paſſion or of coughing, or in any accident which interrupts the lungs? The face of a child during a paroxyſm of the hooping cough, is it not completely black? Is not the hand livid when the arm is compreſſed or tied up, and its blood prevented from returning to the lungs and heart? Are not tumours dark coloured from dilated veins which return their blood too ſlowly? Are not thoſe mulberry marks which are born with us juſt ſmall aneuriſms full of ill oxygenated blood?—Then this firſt effect of oxygenation is a reddening of the blood. The menſtrual blood, the blood of ecchymoſis (as in thoſe who have been whipt), the blood of aneuriſmal bags, are all black; and the blood of varices is ſo very black, that the ancients ſaid they were filled with atrabilis or black bile. The ſtripes inflicted on a ſoldier as a puniſhment are at firſt of the moſt lively red, but ſoon become black.

The next effect of oxygenation is the endowing the blood with a peculiar power, by which it is continually operating upon the living ſolid: this is a power which it is continually loſing; which it is every moment giving up to the ſolids; and which no other proceſs but reſpiration can reſtore. This ſtimulant power the blood gradually loſes as it circulates round the body; it is quite effete when it returns to the right ſide of the heart: the heart of a creature never moves, if we allow its lungs to lie collapſed; but the heart returns to act the very inſtant that pure air is forced into the lungs, and ſo communicated to the blood. This ſtimulant power is moſt of all apparent when we force a living creature to breathe nothing but the pureſt air; for oxygenated or vital air makes this proceſs too rapid; the pulſe riſes, the eyes become red and prominent, the creature ſeems drunk with the new ſtimulus, too great for its ſyſtem. The univerſal heat of its body is greatly increaſed, the

eyes

eyes are turgid and red, and at laſt a ſweat breaks forth all over it; and when dead, the lungs (it is ſaid) are mortified or inflamed. But whatever the marks are, whether theſe ſigns of inflammation be really true, it is plain, ſince the creature dies, that pure air is fatal by a too rapid oxygenation of the blood. If, in our experiments upon a dying animal, we inflate the lungs with mephitic air, the heart does not act; if we inflate its lungs with common air, the heart begins to act; if we inflate its lungs with oxygene air, the heart is irritated to a ſtill more powerful action.

If we open the breaſt of a Frog and ſtop its breathing, we obſerve, firſt, its pulmonic blood florid, and the heart beating ſtrongly: Secondly, in half an hour the pulmonic blood has become dark, and the heart's motion has grown languid; in a little while the pulmonic blood becomes black, and the pulſation of the heart ceaſes: And, laſtly, the trachea of the Frog being untied, and the creature allowed to breathe again, the blood becomes florid, and the heart acts.

OF THE HEAT OF THE BLOOD.

The next effect of oxygene is ſaid to be the communicating of HEAT to the lungs. But I ſuſpect that if the ſmall quantity of oxygene which can enter by the lungs do communicate heat, it muſt be not to the lungs, nor to the blood, but to the whole body through the medium of the blood. There are ſome who pretend to ſay, that when they draw in vital air, they feel a genial warmth in the breaſt, diffuſing itſelf over all the body; but it is eaſy to feel in this way, or any way, when a favourite doctrine is at ſtake, while thoſe who know nothing about doctrines breathe the vital air without any peculiar feeling which they can explain.

There are many circumſtances which make it hard to believe that there is, in conſequence of the oxydation of the blood, any remarkable generation of heat in the lungs. Oxydation of the blood, out of the body, is attended with no increaſe of heat, and yet we operate on a quantity

quantity of blood much greater than that which circulates through the lungs.

To ſuppoſe, but for a moment, that all the heat which warms the whole body emanates from the lungs, were a groſs error in philoſophy; it were to ſuppoſe an accumulation of heat in the lungs equal to this vaſt effect of heating the whole body. But were it ſo, we ſhould feel a burning heat in the centre, a mortal coldneſs at the extremities, and marked differences in the heat of each part in proportion to its diſtance from the lungs. In fevers, we ſhould feel only the intenſe heat of the centre; we ſhould be diſtreſſed, not with the heat in the ſoles of the feet or palms of the hands, or in the mouth and tongue; we ſhould feel only the heat of the lungs. When the limbs alone were cold, would the lungs warm them? How could it warm them up to the right temperature without overheating the whole body? When a part were inflamed, how could the heat go from the lungs, particularly to that point, and reſt there?

From the lungs the heat could not be regularly diffuſed; for in almoſt all the Amphibiæ the lungs are far diſtant from the centre of the body, and could not communicate any degree of heat to the extremities without the greateſt waſte; they would, according to this theory, have lungs for crying with, if they pleaſed to cry, but by no means for diſtributing heat.

But in reflecting upon this moſt difficult of all ſubjects, the generation of heat in the living body, many things are to be taken into the calculation, which ſeem, on the ſlighteſt glance, to be far more important than this depoſition of oxygene from the blood. It is a law of nature, to which, as far as we know, no exception is found, that a body, while it paſſes from an aërial to a fluid form, or from a fluid to a ſolid form, gives out heat. Now, what is the whole buſineſs of the living ſyſtem but a continual aſſimilation of new parts, making them continually paſs from a fluid into a ſolid form? The whole nouriſhment of the body goes on in the extreme veſſels, and is a continual aſſumption of new parts. The extreme veſſels are continually employed in forming ſome acids, which ap-

pear

pear naked in the ſecretions; in forming oxyds, as the fat and the jellies of the membranous and white parts; in the various depoſitions of muſcle, bone, tendon, &c. for theſe are all continually abſorbed, thrown off by the urine, and inceſſantly renewed. They are continually employed in filling all the interſtices of the body with a bland fluid or halitus; they are continually employed in forming ſecretions of various kinds. In performing all this the power of the veſſels may do much; but the ultimate effect in each proceſs muſt be a chemical change, and perpetual changes will produce a conſtant heat. Place the organ and focus of this animal heat in the centre of the body, and you are embarraſſed in a thouſand difficulties; allow this heat to ariſe in each part according to its degree of action, and each part provides for itſelf.

But how then, ſome will ſay, ſhall this heat be regulated? I ſay plainly by the heart and lungs. The lungs regulate the ſtimulant power of the blood, the heart regulates the action of the arteries, in ſo far as regards the ſtimulus of fulneſs and diſtenſion; and with theſe to regulate the centre, nothing can alter the heat of the extremities except partial actions, that is, diſeaſe.

I will conclude then, that oxygene, if it do communicate heat, does ſo, " not to the lungs, nor to the blood, but to the whole body through the medium of the blood."

OF THE RESPIRATION OF ANIMALS.

The effects of oxydation then are, to redden the blood, to renew its ſtimulant power, and to communicate heat, not ſo much to the blood, as to the whole body through the medium of the blood, and to aſſiſt in the ſecretions and chemical changes which are inceſſantly going on in all parts of the ſyſtem. This is accompliſhed by the perpetual and rapid motion of the blood through the lungs; and there it is expoſed to our atmoſphere, which is a mixed fluid very different from what we at

firſt

firſt conceive, or what our ignorant wiſhes might deſire to have it; not conſiſting merely of air fit to be breathed, but for the greateſt part formed of an air which is moſt fatal to animal life, whence it has the name of Azotic Gas. Of an hundred meaſures of atmoſpheric air, we find twenty-ſeven only to conſiſt of vital or pure air, that is oxygene; ſeventy-two conſiſt of azotic air, or nitrogen, as it is called, fatal to animal life; and one meaſure only is fixed air, or carbonic acid, which is alſo an unreſpirable air. But of theſe twenty-ſeven parts of pure air, ſeventeen parts only are affected by reſpiration; ſo that in reſpiration we uſe much leſs than a fifth part, even of the ſmall quantity of air which we take in at each breath.

The change of the air by reſpiration is this chiefly; that the quantity is diminiſhed by the abſtraction of a part of the oxygene; that there is formed a quantity of carbonic acid gas by the union of the carbon of the blood with the oxygene reſpired; and that there is diſcharged along with theſe a quantity of watery halitus. Therefore atmoſpheric air, after it has been breathed, is found to have ſuffered theſe changes: Firſt, It contains now a conſiderable proportion of carbonic acid, which is eaſily diſcovered, and even weighed; becauſe when a cauſtic alkali is expoſed to it, the alkali abſorbs the fixed air and becomes mild. Secondly, It has leſs of the vital air, as is eaſily aſcertained by the eudiometer which meaſures the purity of the whole: And, thirdly, All that remains is merely azotic air, unfit for animal life, or for ſupporting flame. The oxygene, then, in part unites itſelf with the blood; in part it forms fixed air by combining with the carbon of the lungs; in part it forms water by combining with the hydrogene of the blood. Reſpiration frees the blood of two noxious principles, the hydrogene and carbon; and it inſinuates a new principle, viz. the oxygene, into the blood.

Such has been the opinion of chemiſts up almoſt to the preſent day; but the rapid changes of opinion, and indeed of whole ſyſtems, and the confuſion into which the diſcoveries of to-day throws the reſult of all preceding

ceding labours, would almoſt provoke an anatomiſt to put out of his ſyſtem the chemical diſcuſſion altogether, until the maſters of that ſcience have better arranged their materials, and have arrived at acknowledged principles. More careful experiments have proved that all the oxygene taken from the atmoſphere by reſpiration, is conſumed in the formation of the carbonic acid found in the reſpired air; and that the heat evolved by reſpiration is not the heat of the body, but the heat of the air reſpired, latent before, and now become ſenſible, owing to a change of capacity in the gaſes.

The change produced in the blood during the circulation in the lungs, is ſimply to free it of the ſuperabundance of carbon with which it is loaded in conſequence of the ſecretions performed in the extreme veſſels of the ſyſtem of the body.

As to the heat of the body, chemiſts ſeem to have agreed, that full confidence is to be put in the experiments and opinions of Dr. Crauford, whoſe theories have been criticiſed in former editions of this work. The brief abſtract of which doctrine is this. The venous blood has leſs capacity for retaining heat than arterial blood. When the blood of the arteries of the body is converted into purple blood, and enters the ſmall veins, heat is let looſe and becomes ſenſible, giving warmth and a ſtimulus to the operations of the animal economy. When this venous blood is, in the round of the circulation, brought back to the lungs, while it throws out its ſuperabundant carbon, and when this carbon unites with oxygene of the air reſpired, and forms carbonic acid, heat is evolved. While this action of reſpiration is producing heat, it is alſo forming of venous blood arterial blood. And as the arterial blood, in its converſion into venous blood, gave out heat, ſo now, being re-converted into arterial blood, it takes up heat, and that heat is not ſenſible heat, but latent. There is, therefore, no central fire, as it were, in the breaſt, and yet there is a ſource of heat to the whole body from the operation of the lungs. And what degree of heat more than neceſſary for the

converſion

conversion of the blood, and which might be injurious, is expended in forming the vapour exhaled from the lungs.

Nature has appointed but a small proportion of vital air for our use; our atmosphere is so constituted as to hold but a fourth part of vital air, and of that small proportion one half only is used in the lungs. We see by this how necessary this contamination of our atmosphere is, which seems so unfavourable to life; nature intended that we should breathe slowly a modified atmosphere! With nothing but the purest air to breathe, our life would be quickly consumed, like that deflagration of iron, which is so rapid in vital air, while it burns so moderately and slowly in the common air.

These assistances which we have from chemistry are but a promise of what that science may do; nothing of all that we know concerning the chemistry of the blood is either perfect or sure: we have our expectations still of seeing things more completely explained; but our expectations are not like those of Mr. Moises, who, in a certain dissertation on the blood, seems so full of his new lessons in chemistry, and so confident of his future achievements in that science, as to expect that muscular motion shall be very thoroughly explained, and that it will be found to be nothing else, in all the world, but " an explosion of hydrogene and oxygene," and God knows what!—but it is after the manner of " a steam engine;" and if his scheme holds, they are to be fired off " by means of the nervous electricity of Galvani *!"

* Vide page 236.

OF THE MEMBRANES WITHIN THE THORAX, AND OF THE HUMAN LUNGS *.

We have underſtood that the thorax is wide at the loweſt part, and contracted above; formed by the ſpine on the back part, the ſternum before, and the ribs on the ſides; we know how to attribute the general form, as well as the motion to which the whole thorax is ſubject in reſpiration, to the form of the ribs, and the diſtinction in their lengths.

We have next to underſtand that the ſpaces betwixt this texture of bones are filled with muſcular ſubſtance, and the cavity thus formed lined by a membrane called *Pleura.*

Within the protection of the cheſt or thorax there are many important parts; the heart, with its capſule and great veſſels; the lungs; the thymus gland; and œſophagus: beſides which, the unmeaning ſchool-boy's leſſons in anatomy contain the enumeration of the duplicatures which the pleura forms; and the trunks of all the veſſels; the aorta, the pulmonic artery, the venæ cavæ, and vena azygos, the thoracic duct, and glands of the abſorbing ſyſtem; beſide the trunks of the nerves, the phrenic, the ſympathetic, the 8th pair of nerves; things better explained in combination with the parts of the ſyſtem to which they immediately belong. It is ſufficient at preſent to obſerve, that of the parts contained in the thorax, the lungs alone are ſubject to the influence of the cheſt's motion in reſpiration.

The *Pleuræ* are two diſtinct membranes lining the two ſides of the cheſt. Theſe membranes moſt reſemble the peritoneum. The ſurfaces are ſmooth, and exude a lubricating moiſture. They are vaſcular, and particularly ſubject to inflammation; and conſequently to all the effects of inflammation, inflammatory cruſt, adheſions, collections of pus, (empyema,) and collection of water, (hydrothorax,) and oſſeous lamina.

* By Charles Bell.

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The *Pleura Pulmonum* is the inveſting membrane of the lungs, and it is called pleura becauſe it can be traced from that membrane which lines the ribs, and which, from that circumſtance, is diſtinguiſhed by the term *Pleura Coſtalis*. When we trace the membrane of the ribs over the lungs, we comprehend how the ſmooth and proper ſurface of the one is internal, and the other external; and yet that theſe ſurfaces are continuous and the ſame. We underſtand too how the ſurface of the pleura pulmonalis and coſtalis are in cloſe contact, and yet do not adhere, and that conſequently freedom is given to the motion of the lungs. At leaſt, if in reſpiration the lungs do not move from the ſides of the cheſt, they are not prevented by the adheſion of the pleura, when in a healthy and natural ſtate; but by a circumſtance already in part explained. The lungs cannot recede from the pleura covering the ribs, becauſe no air can be admitted to fill the ſpace which would be then neceſſarily formed betwixt the lungs and ribs.

The *Ligaments* of the lungs are underſtood when my reader comprehends the manner in which the pleura is reflected from the ribs over the ſpine, and from the ſpine over the great veſſels and over the lungs. Where this reflection of the pleura takes place, embracing the tubes and veſſels going to the ſubſtance of the lungs, it forms ligamentous roots, the only natural connection of the lungs to the cheſt.

THE MEDIASTINUM is a partition dividing the great cavity of the cheſt into two lateral parts: it is ſtretched from ſpine to ſternum. This is a common, it may be a true deſcription of the mediaſtinum as far as it goes, yet it is a moſt imperfect one. This partition of the thorax is eſteemed a proviſion for our ſafety worthy of all admiration; and ſo indeed it is. But when it is ſaid, that this partition provides that a man, being diſeaſed in the lungs of one ſide, or wounded betwixt the ribs of one ſide, he may ſtill breathe with the other, I would venture to ſay, that it is a wrong reading in that volume which it ought to be our pride to preſerve pure. Every motion of the natural ſyſtem has its proper check, every

delicate part has its guard againſt the violent motions of the natural ſyſtem; and is conſtituted with a due proviſion againſt the injuries we are liable to in a ſtate of nature. But nature had it not in contemplation that we ſhould be expoſed to the gun and bayonet; nor can I think with a celebrated anatomiſt that ſhe has provided for ſuſtaining the prolonged exiſtence of him who is ſlowly waſted by pulmonary conſumption. I cannot believe that there is either in the foramina of the heart, or the mechaniſm of the cheſt, a proviſion againſt the effects of diſeaſe. I have therefore to ſhow that the mediaſtinum has a reference to the ſupport of the heart and great veſſels, againſt the unequal preſſure to which, without this guard, they would be expoſed in the neceſſary and natural changes to which the body is ſubject in health. But I have ſaid that the deſcription of the mediaſtinum is imperfect; and really, though ſeemingly ſimple, it is difficult to repreſent by words the connection of the membranes of the thorax.

The two diſtinct ſacs of the pleura, each forming a lining membrane to the two ſides of the thorax, approach towards the centre of the cavity, and would abſolutely unite but for the intervention of the heart and its appendages. And ſo indeed it is, that anterior to the heart and poſterior to it, theſe membranes nearly touch. Where the ſacs of the pleura approach each other anterior to the heart, they form the ANTERIOR MEDIASTINUM, and in the ſame manner behind the heart and near the ſpine, they form the POSTERIOR MEDIASTINUM.

The anterior, or pectoral mediaſtinum, has, in the embrace of the membranes, much cellular membrane; and when in diſſection we raiſe the ſternum, this looſe cellular membrane allows the pleura to be drawn ſeparate ſo as to form a cavity, which cavity did not previouſly exiſt. The anterior mediaſtinum contains the thymus gland, ſome abſorbent glands, a conſiderable trunk of the lymphatic ſyſtem, which has been called the DUCTUS THORACICUS ANTICUS.

The poſterior mediaſtinum, called ſometimes DOR-

SALE, contains the extremity of the trachea and part of its branches called bronchi, and part of the pulmonic artery and veins; the œſophagus, for the greater extent of its courſe, the deſcending aorta, and the great trunk of the abſorbents, the thoracic duct, the eighth pair of nerves, and the dorſal lymphatic glands.

Both the mediaſtina are a little towards the left ſide, and the poſterior one is much the longeſt.

I now leave authority, and proceed to deſcribe the more important connections of the membranes of the cheſt with the heart and great veſſels. The pleura, which is a very thin and weak membrane, where it inveſts the lungs or adheres to the inſide of the ribs, is particularly ſtrong where it is reflected from the diaphragm. And from the diaphragm to the upper and more contracted part of the cheſt, all along the tract of the cava, it is of a ligamentous firmneſs, and is more like a faſcia or tendon than thoſe layers of cellular tiſſue, which have of late got that name in connection with the ſubject of hernia. Towards the upper part of the cheſt, the pleura, or rather the mediaſtinum, covers and embraces the branches of the cava, and poſteriorly it covers and protects the aorta and thoracic duct; in ſhort, were it not the fear of confounding the ideas of the younger ſtudents, I would ſay, that this ſtructure of membranes excludes all but the lungs from the cavity of the cheſt; and conſequently from the effect of the cheſt's motion in reſpiration. How the reſpiration does not affect the veins and cavities of the heart, will now, I truſt, be eaſily conceived, and conſequently the uſe of the mediaſtinum be underſtood.

The enlarged capacity of the thorax in every direction, the raiſing of the ribs, the thruſting out of the ſternum, is attended with the contraction and ſinking of the arch of the diaphragm. But this motion which expands the cells of the lungs, and draws the air into them, would diſorder the heart's motion, would cauſe a lodgment of the blood and diſtenſion of the great veins and ſinuſes, were they under the influence of the motion of reſpiration. But the diaphragm moves only on its lateral

parts, or it is checked and intercepted at the middle part by the connections of the mediaſtinum. In proportion as the lateral cavities of the cheſt and the lungs conſequently ſuffer the influence of this expanſion of the cheſt, and have the preſſure taken from them (which bore againſt the weight of the atmoſphere) the parts contained in the mediaſtinum ſuffer preſſure by the action of the diaphragm and riſing of the ſternum. If the veins near the heart were expoſed to the ſame influence that the lungs are, they would be ſubject to the ſame change of quantity of what they contain; the blood would be accumulated in inſpiration, and forced out from them in expiration, and the regular action of the heart interrupted or diſturbed.

There is a further uſe in theſe connections of the membranes ſurrounding the great veſſels with the diaphragm, viz. to preſerve an equilibrium or equal preſſure upon the great veſſels of the trunk during the violent action of the muſcles. Thus in leaping, pulling, or ſtraining, in any way, there is a ſudden and great preſſure on the viſcera and veins of the abdomen, and at the ſame time there is a powerful acceleration of the blood from every remote part towards the great veins and right ſinus of the heart. Theſe veſſels would be overpowered and burſt but for the protection of the mediaſtinum, and the ſupport which the diaphragm gives by its connection with the mediaſtinum, and by acting in oppoſition to the abdominal muſcles.

OF THE THYMUS GLAND.

The thymus is a gland of a pale colour and ſoft conſiſtence having many diviſions or lobuli. It lies immerſed in the cellular membrane of the anterior mediaſtinum, but ſtretches upwards on the neck, and its extremities are betwixt the trachea and carotid arteries, but it lies principally on the pericardium. It has two ſuperior cornua, and two inferior, the right of which is the longeſt. On puncturing this gland a white fluid may be expreſſed, and when we blow into this puncture the air pervades

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the whole gland, giving the appearance of a cellular texture; but no ducts have been discovered. The thymus occupies a very considerable space in the chest of the fœtus, while it diminishes rapidly during childhood; therefore it is presumed, that it has a function adapted to some peculiarity of the fœtal circulation: but not even a probable conjecture has been offered further. It has been supposed a kind of diverticulum chyli. It has been supposed to secrete a fluid to attenuate the blood; it has been supposed to separate a peculiar fluid which was again thrown into the blood through the small veins. It has been supposed useful to fill up the thorax during the contracted state of the lungs in the fœtus; forgetting altogether that it is large in the fœtus and diminishes after birth, it has been supposed to protect the lungs from the pressure of the sternum; all which are suppositions merely, that have not the most distant proof to support them, and yet possess not sufficient absurdity to make them worthy to be recollected on that account.

OF THE LUNGS.

THE LUNGS are the soft compressible bodies which fill the two lateral cavities of the chest; and their function is to convey the atmospheric air into contact with the circulating blood. They consist principally of a cellular texture, and air tubes communicating with the atmosphere through the trachea. The degree of fleshy consistence and solidity which they have, is owing to the many vessels which carry blood through them, and the firm texture of membrane necessary to support them.

The lungs of the left side are divided into two great lobes, those of the right side have a third lesser and intermediate lobe. In the adult body the lungs are of a livid blue colour, and are sometimes marked with black spots; in youth they are more of a fleshy colour, and in infancy of a still paler cast. In form the lungs correspond to the cavity which contains them when taken from their place and extended. They are wide below, and rise conically

nically upward; concave where they lie on the arch of the diaphragm, obtufe above, convex forward, and more flightly fo on the fides; they have a deep fulcus behind left for the fpine, and within the projecting lobes there is a place of lodgment for the pericardium and heart.

OF THE TRACHEA AND BRONCHI.

The trachea is that extent of the wind-pipe which is betwixt the LARYNX (already defcribed), and the divifion of this tube where it is about to enter the lungs. It is feated on the fore-part of the neck and anterior to the œfophagus or gullet. It is covered by the thyroid gland and the flat mufcles going from the fternum to the os hyoides and thyroid cartilage, and all around, it has a very loofe and elaftic cellular membrane.

The trachea is not a perfect cylinder, it is flat on the back part; it is rigid to admit of the eafy paffage of the air through it; and this rigidity is derived from the cartilaginous hoops of which it is principally formed. Thefe are not perfectly regular: above they are moft fo, and are broader, and have weaker cornua the nearer the bifurcation: they are united by an intermediate ligamentous fubftance, which fome will have to be mufcular.

The membrane lining the trachea, and continued from the larynx into the cells of the lungs is foft, elaftic, and vafcular; many pores or foramina open upon it, efpecially about the larynx and epiglottis. They are called the openings of the ducts of glands, but in truth they are the fecreting parts themfelves; and a fheathing mucus flows from them. The moifture which bedews the trachea is a limpid bland mucus which fubfides in water, unlefs air bubbles be in it. The thinner part of this fecretion is carried off by the air which paffes through the trachea, and the thick matter is expectorated.

From its expofed fituation, its fenfibility and vafcularity, the membrane of the trachea is very fubject to difeafe.

disease. I have now before me examples of general inflammation, of inflammatory crust, of suppuration, and deep ulcer in the inside of the trachea. Often lesser degrees of inflammation change the nature of the bland secretion, making it more saline, acrid, and stimulating. Sometimes the inflammatory action will mix a portion of coagulable lymph with the mucus secreted, and which, by this addition, will take a tubular form, as in the croup. But let it be remembered, that coagulable lymph in the form of tubes or vessels may be coughed up from the lungs, a consequence of blood poured into the bronchi without the presence of inflammation.

OF THE BRONCHI.

On entering the thorax the trachea inclines backward and passes into the posterior mediastinum and behind the arch of the aorta and before the œsophagus; opposite to the third vertebra of the back it divides into two branches passing to the right and left; these and their subdivisions are the bronchi.

When we follow one of these tubes we find it entering the substance of the lungs, accompanied by blood vessels, branches of the pulmonary artery, with their corresponding veins; and lesser arterial branches enter here, which are derived from the aorta, and are called the bronchial arteries.

The bronchi divide and subdivide in regular order, branching like a tree through all the substance of the lungs, until their tender extremities terminate in the air cells; for the cartilaginous rings of the bronchi which near the trachea resemble those of the trunk, become weaker and further removed from each other, until the extremities seem only to be membranous tubes.

The BRONCHIAL CELLS, into which the air is admitted in respiration, have been represented as very regular sphericles attached to the branches of the bronchi, and having no communication with each other. I rather believe that they are not regular in figure nor in size, and

and that they freely communicate. Perhaps I am miſtaken in ſuppoſing I ſee that the cells not only communicate, but that the air is drawn through them, and made to circulate among them in a ſeries. Taking this as a queſtion to be judged of more by the probable effect of the ſtructure, than by what we can demonſtrate, would not the air, in the ſuppoſition of its being drawn through the communications from cell to cell, in connection with the extremity of a branch of the bronchus, be more effectually brought into contact with the blood, than if the extreme branch of the wind-pipe terminated in a cell which had one opening only, and which cell contracted during expiration, only in a ſlight degree?

On theſe cells the ultimate branches of the pulmonary arteries and veins ramify and inoſculate, and the thin membrane of the cell and the coats of theſe minute veſſels do not prevent the influence of the air upon the circulating blood. My reader muſt well diſtinguiſh betwixt this regular cellular ſtructure, for the admiſſion of air which is drawn through the trachea and bronchi, and that cellular texture of the lungs which is common to them and every part of the body; a tiſſue which ſupports the air cells, the bronchi, and the three ſeveral kinds of blood veſſels, and the lymphatics which collectively conſtitute the ſubſtance of the lungs. This common cellular ſubſtance ſupports the air cells, and unites the lobules, and conveys the veſſels to their deſtination.

Coloured water, or ſize, or oil of turpentine being injected into the pulmonary artery, returns by the pulmonic veins, running in what is called the leſſer circulation. The ſame fluids being injected into the vein, return by the artery. The fluid being more forcibly propelled into the pulmonary artery, flows by the trachea, and the exudation of the fluid is facilitated, if the action of reſpiration be imitated by blowing into the trachea at the time of the injection. Theſe coarſe experiments in the dead body prove little; but the courſe of the blood from the extreme pulmonic arteries into the veins, having been ſeen in the membranous lungs of the lacertæ, the chemical phenomena exhibited by reſpiration, leave

little

little for us to wiſh further in explanation of the functions of the lungs.

Respiration carries away the ſuperfluous carbon of the blood, beſtows heat and ſtimulates the ſyſtem, endows us with the power of ſpeech, and affords us the ſenſe of ſmelling, or greatly contributes to the perfection of the ſenſe.

For the conſent or ſympathy of the lungs with other parts, ſee the obſervations under the head of *Par-vagum*, in the deſcription of the nerves.

END OF THE FIRST VOLUME.

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